

**NIOSH Guide to the Technical Use of Chemical, Biological, Radiological, and Nuclear (CBRN) Open
Circuit, Pressure-Demand, Self-Contained Breathing Apparatus (SCBA) Respirators Certified Under
42 CFR Part 84**

CBRN SCBA User's Guide

(OD Review # 04031)

Department of Health and Human Services

Centers for Disease Control and Prevention

National Institute for Occupational Safety and Health

National Personal Protective Equipment Technology Laboratory

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DHHS (NIOSH) Publication No. 2005-XXX

DECEMBER, 2005 (Target Publication Date)

(EID recommends the editor establish the official publication date using month and year.)

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FOREWORD

The workplaces of United States civilians, especially emergency responders, are considered inherently more dangerous. The occupational safety and health measures to protect those workers in a terrorism workplace continue to evolve. The control measures to safely work in those workplaces are still being defined as new understandings of terrorism potentials, emergency response preparedness and life-saving actions emerge. The occupational workplaces of emergency responders have changed and are expected to continue to change however; the basic tenets of emergency response – timely response, saving lives, protecting property, containing the threat and mitigating the threat- are staying constant. NIOSH realizes this and has been documenting, evaluating and creating new protection standards in support of other joint federal efforts focused on terrorism response and the changing workplace dynamics of occupational safety and health.

The purpose of the U.S. Occupational Safety and Health Act of 1970 (Public Law 91-596/OSHA) is to assure safe and healthful working conditions for every civilian working person and to preserve human resources. In this Act, the National Institute for Occupational Safety and Health (NIOSH) is charged with recommending occupational safety and health work standards for all adult workers. These include, but are not limited to, describing workplace exposures that are safe or evaluating engineering and personal protective equipment technologies that mitigate workplace exposures to a safe level, for various periods of employment, so that no worker will suffer diminished health, functional capacity, or life expectancy, as a result of his or her work experience. The malicious use of chemical, biological, radiological and nuclear agents (CBRN), from terrorist attacks or other sources, have the potential to create extreme adverse workplaces and to diminish occupational worker health, functional capacity or life expectancy if not properly protected against. Available protection programs consist of engineering controls, remote and active sampling methods, personal protection

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equipment usage, and the conduct of administrative training and maintenance programs. NIOSH contributes to these personal protection programs in so many ways from an industrial work perspective and now NIOSH is providing a first-of-its-kind CBRN SCBA User's Guide for all emergency responders and supervisors.

The CBRN SCBA User's guide focuses on the open circuit, pressure-demand, self-contained breathing apparatus respirator, commonly known as a SCBA. The purpose is to assist individual emergency responders, SCBA maintenance technicians, and respirator protection program managers in developing applicable use guidance, also known as "best practices". The guide outlines key points that tell a responder how to recognize new or used NIOSH-approved CBRN SCBA and what the limitations are of the CBRN SCBA, while at the same time, it provides best practice use guidelines oriented on what to do before, during, or after a CBRN terrorist incident.

NIOSH's National Personal Protective Technology Laboratory (NPPTL) was established in 2001 to provide world leadership and scientific expertise in the prevention of work-related injury and illness by ensuring the development, certification, deployment and use of personal protective equipment and integrated ensembles. One of the recent NPPTL respirator certification standards defines the requirements for NIOSH-approved CBRN SCBA specifically addressing emergency responders and other trained public safety personnel.

The NIOSH-approved CBRN SCBA has multipurpose uses. Fire service responders requiring structural fire protection, hazardous materials protection and CBRN/weapons of mass destruction protection in one type of SCBA have it in the NIOSH-approved CBRN SCBA. The same CBRN SCBA can be used for structural fire

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or hazardous materials as it is used for CBRN agent response. For those responders that have law enforcement requirements, the CBRN SCBA, has integral traditional NIOSH industrial protections, fire resistance qualities and CBRN protection. These protective qualities in a CBRN SCBA offer unique benefits for *known* special law enforcement teams involved in methamphetamine laboratory raids, rendering-safe chemical or radiological improvised explosive devices (IED) or containing the CBRN effects of a terrorist weapon of mass destruction.

The NIOSH guidelines in this publication allow an emergency responder to determine how to attain the best performance from a CBRN SCBA under specific use conditions and how to contribute to better training, better preparedness and better response capability. During the initial response to a CBRN terrorist incident, fast incident command decisions involving response and recovery rely on timely respirator and other personal protective equipment (PPE) selection decision logics. Responders should use integrated CBRN PPE selection logic that is based on the federal assessment of a specific respirator assembly/configuration performance. Performance that proves the respirator, as a complete respirator system, has passed stringent laboratory tests against known chemical warfare agents and fit-factor protection level corn-oil particulates. A NIOSH-approved CBRN SCBA provides that level of known performance.

The NIOSH testing and certification of a CBRN SCBA and, thus its performance, is unparalleled in national and international respirator certification programs. While the performance is unparalleled, the CBRN SCBA has limitations of use that define this unparalleled protection.

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The protection of emergency responders is not indefinite in a CBRN incident and, therefore, all emergency responders and their personal protective equipment are subject to the penetrating or permeating affects of commercial industrial chemicals or military-type chemical warfare agents over time. NIOSH recognizes these effects and protects against them by providing NIOSH-approved CBRN respirators to the national inventory of respirators on a foundation of unique safety statements that apply to specific CBRN approved respirators. NIOSH uses these safety statements, commonly known in NIOSH language as "cautions and limitations", to express the known limits of a respirator as being worn properly on a human test subject or laboratory head form. NIOSH publishes these safety statements unique to each class of respirator.

Primarily, when known chemical warfare agent contamination is present in any physical state, the CBRN SCBA has a CBRN Respirator Use Life (CRUL) limitation of six/6- continuous/elapsed hours. In other words, you should be removing it from your body no later than the start of a 6th hour of elapsed use. The six hours apply to the hardware components of the SCBA, minus the assigned cylinder. The six hour limitation does not apply to accessory protective suit or clothing worn in conjunction with the SCBA. This CBRN SCBA six-hour/6-hour limitation is designed to provide the safest level of protection to the emergency responder. If used correctly, the risk associated with respiratory exposure to CBRN agents is minimized by the proper use of a NIOSH-approved CBRN SCBA. The protection provided to the responder is maximized, if the CBRN contaminated SCBA is no longer used after the six-hour limit. Six hour time management process should include a clear understanding of the NIOSH CBRN SCBA cautions and limitations applicable to that specific model of CBRN SCBA in an effort to allow incident commanders and site safety officers the ability to forecast CBRN SCBA change out schedules in support of a long term incident response and recovery period. This document is the first of its type and is a foundation for a comprehensive NIOSH special hazard family of CBRN respirator use guides.

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The guide is based on three primary sources of input: First, the technical requirements defined in a NIOSH policy letter to all respirator manufacturers, dated December 28, 2001; Second, the NIOSH statement of standard and standard test procedures for that policy letter; And third, best practices summarized from a multitude of internal NIOSH reviewers, select first responders and the NIOSH NPPTL interpretation of those first responder comments. The CBRN SCBA User's Guide is the result of a joint federal effort that has produced a technically sound, user responsive, threat oriented CBRN SCBA standard tailored to the realities of a most credible terrorist event involving chemical, biological or radiological agents.

Emergency responders that participated in the Department of Homeland Security (DHS) *Top Officials 3* (TOPOFF 3) terrorism response exercise, April 4 to April 8, 2005, had NIOSH-approved CBRN SCBA available. Nationwide, DHS full scale training exercises are occurring in cities as funding is available. CBRN APR, CBRN SCBA and traditional SCBA are playing prominent roles in protecting responders in these exercises and contributing to a higher state of preparedness. Couple the trained focus intensity of current day virtual SCBA training programs with appropriate protective clothing/ensemble training programs; the emergency responders participating in DHS training exercises and real world responses are better prepared to perform their tactical and strategic response missions in current HAZMAT/Clandestine Laboratory and future CBRN environments.

It is with humble pride and great honor that I offer this first of its kind, special hazard CBRN respirator use guide to the emergency responders working in the evolving workplaces of the United States of America.

Director's Signature Block

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PREFACE

Under the authority of 42 CFR Part 84, 84.63.(c), the National Institute for Occupational Safety and Health reserves the right to require, as a further condition of approval, any additional requirements deemed necessary to establish the quality, effectiveness and safety of any respirator used as protection against hazardous atmospheres. In accordance with the cited paragraph, NIOSH implements, by policy, the testing and federal approval of respirators for Chemical, Biological, Radiological, and Nuclear (CBRN) protection.

NIOSH, and the US Army Research and Development Engineering Command (RDECOM, formerly SBCCOM), as part of a negotiated federal Interagency Agreement (IAA) with the National Institute of Standards and Technology (NIST), have jointly developed CBRN respirator certification standards designed to protect the emergency responder and supporting public safety emergency response personnel.

In 1999, NIOSH proactively conducted a chemical and biological respiratory protection workshop that started gathering stakeholder interest and focusing NIOSH efforts on CBRN respirator certification. Prior to September 11, 2001 and subsequent anthrax exposure in October, 2001, emergency responder concerns raised by the International Association of Fire Chiefs (IAFC), the International Association of Fire Fighters (IAFF) and the National Fire Protection Association (NFPA) caused speculation over whether a traditional NIOSH-approved SCBA would protect against an exposure to chemical warfare agents. In response to those concerns, NIOSH public meetings and the aftermaths of September 11, 2001 and October 2001, NIOSH fast

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tracked the open-circuit SCBA CBRN respirator standard development and started testing in January, 2002.

The NPPTL accomplished this standard development for NIOSH expeditiously and is continuing to progress

in the development of test methods and certification procedures for other types of CDBRN respirators.

CBRN agents encompass lethal, less-than-lethal, and harassing chemical compounds, particulates and organisms: each with a unique physical science and history. It is common knowledge that the respiratory tract is the fastest route of entry for most CBRN agents. Exposed skin is also a route of entry for CBRN agents. Civilian respirators that carry the NIOSH CBRN approval/certification are evaluated by NIOSH and meet minimum NIOSH CBRN performance requirements for protecting the respiratory system, specifically the oral/nasal breathing zone (mouth and nose area) of a civilian emergency responder, against CBRN agents. NIOSH does not currently issue CBRN certifications or approvals for other PPE items such as protective clothing, suits, gloves or footwear. However, select accessories that attach to respirators can attain NIOSH CBRN approval, as accessories to the primary respirator system approval, by undergoing the same tests while attached to the respirator.

The NIOSH-approved CBRN respirators provide a federal proven level of respiratory protection against weapons of mass destruction (WMD) involving chemical, biological, or radiological agents. It is possible that these agents may be crude airborne hazards generated from terrorist deliberate release(s) of toxic chemical compounds, biologic toxins, biologic particulates, radiological particulates or nuclear detonations. The agents could also be the result of an inadvertent or accidental release of any of those types of hazards, the release of toxic industrial chemicals or catastrophic natural disasters in any global location.

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The term *Weapon of Mass Destruction* (WMD) is defined by the U.S. Department of Homeland Security (DHS) National Response Plan (NRP), December 2004. Per the DHS, the NRP is an encompassing all-discipline, all-hazards plan that establishes a single, comprehensive framework for the management of

domestic incidents. The plan defines WMD, in accordance with Title 18, U.S.C. 2332, as (1) any explosive, incendiary, or poison gas, bomb, grenade, rocket having a propellant charge of more than 4 ounces, or any missile having an explosive or incendiary charge of more than one-quarter ounce, or any mine or similar device; or (2) any weapon that is designed or intended to cause death or serious bodily injury through the release.

The relevancy of the NRP to NIOSH CBRN respirator standards development and certification programs is based on having an awareness of what the perceived threat is to workers on the WMD terrorism site. The DHS WMD definition provides a starting point definition for the conduct of occupational safety analysis, as it relates to working in a WMD incident site and, specifically, a CBRN suspected or confirmed contaminated incident.

The use of the acronym *CBRN* is considered a more accurate reflection of NIOSH research to practice strategy related to respirator performance certification programs rather than the WMD acronym. A strategy that incorporates efficacy studies on chemical warfare agent physical effects, chemical warfare agent toxicology data and insights gained from certifying the protective qualities of materials and air pressure boundaries against chemical warfare agents and particulates.

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NIOSH adopted the acronym *CBRN* in 2001 to substitute for WMD, with a distinct variation. NIOSH uses

CBRN to categorize a protection rating that focuses on the respiratory hazards and the protection required to protect against respiratory hazards unique to *CBRN* agents but not necessarily the explosive traits of the WMD definition. NIOSH does not address the protections required to protect against the explosive

propellants in the DHS WMD definition. NIOSH respirators when properly maintained and donned are expected to provide a level of respiratory protection against the fumes generated from a conventional or non-conventional explosion but not the blast wave or ballistic debris/shards created by that explosion. When the explosive effects of weapons are considered an acronym similar to *CBRN* but with an “E” at the end is used (*CBRNE*). The “E” addition signifies that the threat from conventional and non-conventional explosions is also considered. NIOSH does not add the “E” for explosives in *CBRN*. In accordance with NIOSH, the *CBRN* acronym stands for Chemical, Biological, Radiological, and Nuclear. The use of the word “or” between the words “radiological” and “nuclear” is not recommended. The use of *CBRN* before a particular category of NIOSH-approved respirator serves to identify the respirator as having a unique *CBRN* approval. For example: *CBRN* SCBA, *CBRN* Air-Purifying Respirator (*CBRN* APR), *CBRN* Air-Purifying Escape Respirator (*CBRN* APER), *CBRN* Self-Contained Escape Respirator (*CBRN* SCER) or *CBRN* Powered Air-Purifying Respirator (*CBRN* PAPR) show five categories or classes/types of respirators that can be *CBRN*-approved. Integration of these types of respirators into occupational health and safety training programs benefits emergency responders by providing respirators tailored to *CBRN* response incident operations.

As a reference document in training programs, the *CBRN* SCBA User’s guide provides guidelines on:

- 1) What is a *CBRN* SCBA?
- 2) How to check a field deployed or new SCBA for NIOSH-approved *CBRN* certifications,

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- 3) How to differentiate between 3 possible types of SCBA that can be found in the emergency response workplace: Industrial SCBA (NIOSH-approved), Fire SCBA (NFPA compliant and NIOSH-approved) and CBRN SCBA (NIOSH-approved, NFPA compliant and NIOSH-CBRN tested and approved)
- 4) How to prepare CBRN SCBA respirators for CBRN response,
- 5) How long to use CBRN SCBA respirators in potential or known CBRN incidents
- 6) How to discard contaminated CBRN SCBA respirators after use.

Emergency responders have unique crisis response and consequence management workplaces that currently include a full spectrum of all-hazards. Chemical, biological, radiological, nuclear (CBRN) weapons, used by terrorists or others hostile to the United States, cannot be excluded from being a potential respiratory hazard to the workers of this nation in those crisis or consequence management workplaces. Training programs that are proactive in seeking CBRN best practices will benefit the emergency responders who participate avidly and regularly in them.

Developing NIOSH-approved CBRN respirator technology to protect against CBRN weapon threats, and preparing plans to integrate and train on that certified CBRN respirator, are actions that may deter a terrorist from using CBRN agents. NIOSH CBRN respirator standards may serve as a technical obstacle to the terrorist or universal adversary seeking to capitalize on the outcomes of any incident of national significance involving CBRN agents. A perspective that a CBRN incident may be a once-in-a-life time response for an emergency responder may cause a responder municipality to debate over purchasing CBRN SCBA. However based on the knowledge of the effects of CBRN agents, having a non-CBRN SCBA to respond to that event, is not worth the risk for that one time or multiple potential exposures during that once-in-a-life time response. It is possible that terrorism incidents may not be once-in-a-life time events. Take for example the two World

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Trade Center Attacks, one in 1993 and a second in 2001. The attacks were 8-years apart but the same area was attacked using two different attack techniques and several of the firefighter responders that worked the

September 11, 2001 response, were also responders that worked the 1993 incident. Incidentally, the 1993 attack studies show traces of blood agent present.¹

The NIOSH CBRN SCBA provides the highest known level of man-portable respiratory protection for these events. Proper use of the respirator is expected to benefit the user and positively contribute to improved occupational safety measures on the incident site. A multitude of training challenges facing emergency responders in a CBRN environment exist and if a nationally significant CBRN attack or attacks occurs, all available resources will be needed to set the responder up for success in that workplace. A NIOSH family of special hazard CBRN respirator use guides, designed with the end user and respirator protection program manager in mind, is being published. This NIOSH CBRN SCBA User's Guide is the first guideline document, in that family of publications.

¹ Eckstein M [2004]. Cyanide as a Chemical Terrorism Weapon. Jems Communications Summer 2004 (Suppl):22-31

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ABSTRACT

The NIOSH CBRN SCBA User's Guide outlines guidelines and recommendations concerning the use of a Chemical, Biological, Radiological, and Nuclear (CBRN) Self-Contained Breathing Apparatus (SCBA) respirator in emergency response to events of national significance as defined by the U.S. Department of Homeland Security. A CBRN SCBA is a unique respirator, approved by the NIOSH – NPPTL, and recognized by OSHA, DHS, NFPA and the IAB for use in work-related-CBRN event catastrophes. The guide is adequately comprehensive in that it covers all technical descriptions of the CBRN SCBA requirements, design components, unique certification production model markings, NIOSH labels, SCBA service life concepts, SCBA rated service time concepts, CBRN SCBA Respirator Use Life (CRUL) concepts and select protective clothing/ensemble suit interfaces.

The document provides critical respirator use life guidance to emergency responders trained to use CBRN SCBA in responding to CBRN terrorism or copycat incidents. New CRUL recommended guidelines for use of a CBRN SCBA *before* incident operations, *during* CBRN incident response and *after* CBRN incident response are discussed. CRUL guidelines and time values are simply best practice interpretations of the NIOSH-approved cautions and limitations published with every CBRN respirator approved by the NIOSH. NIOSH CBRN SCBA Cautions and Limitations applicable to the CBRN SCBA are discussed in detail. It is shown how they are the lynchpin between the end user and the satisfactory performance of the CBRN SCBA.

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Satisfactory performance that is proven and provided to the public based on the NIOSH granting approval to the manufacturer's SCBA respirator system, in accordance with 42 CFR Part 84 and the NIOSH CBRN SCBA Statement of Standard.

To be proficient on the use of the CBRN SCBA, the end user must understand and know the cautions and limitations assigned to the respirator. While routine methods of how to don, use and doff the SCBA have not changed, the amount of time a confirmed contaminated chemical agent CBRN SCBA is used in an incident response is new. Any unique respirator manufacturer special instructions or designs applicable to the CBRN SCBA are addressed in the user instructions. The amount of time a contaminated SCBA exposed to chemical agents has is contingent on knowing if the CBRN SCBA is in fact contaminated, when it was contaminated and whether spot decontamination was done. The amount of time that an end user can safely use the respirator and not fear CBRN permeation or penetration is 6-hours and that is known as a CBRN Respirator Use Life value, or CRUL value. This CBRN SCBA User's Guide assists the end user in understanding the complexities of a CBRN SCBA and how its CRUL value is attained. The cautions and limitations form the basis for the CRUL value of 6-Hours for a confirmed chemical agent contaminated CBRN SCBA. NIOSH CBRN SCBA is not recommended for continued use longer than 6-hours, if known to be contaminated by chemical warfare agents. The six hour CRUL value is designed to provide the minimum protection afforded by a NIOSH-approved CBRN SCBA. The total CBRN SCBA system service life or break through, at known laboratory certification live agent test concentrations, is not applicable out of the interest of offering the emergency responder the highest amount of safety available while wearing the CBRN SCBA in a contaminated CBRN atmosphere over six hours. Granted SCBA are restricted in use time by the amount of

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compressed air in the cylinder and pressure duration range, a CBRN SCBA respirator system using refilled cylinders or replaced cylinders has a CBRN respirator use life time of no more than 6-hours/360-continuous minutes for all components of the respirator.

The recommended guidelines can be used by respiratory protection program administrators, however, the guide is intended to assist first-in fire fighters, first-in emergency medical personnel, first-on-scene law enforcement officers, first entry-law enforcement tactical officers and teams, responding incident safety officers and other public safety or services personnel (paid or volunteer) that require the use of NIOSH-approved (OSHA and DHS endorsed) CBRN SCBA.

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ACRONYMS

A

AEGL - acute exposure guideline level

APF - assigned protection factor

APR- air-purifying respirator

B

BA - breathing apparatus

BWA – biological warfare agent

B-NICE – biological, nuclear, incendiary, chemical, and explosive

C

CBR - Chemical, Biological, or Radiological

CBRE – Chemical, Biological, Radiological or Explosive

CBRN - Chemical, Biological, Radiological, and Nuclear

CBRNE - Chemical, Biological, Radiological, Nuclear, and Explosive (low or high-yield explosive)

CDC - Centers for Disease Control and Prevention

CFR – Code of Federal Regulations

CGA – Compressed Gas Association

CRUL – CBRN Respirator Use Life

CWA - chemical warfare agent(s)

D

DoD/DOD – Department of Defense

DOJ – Department of Justice

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DHS- Department of Homeland Security

DOT – Department of Transportation

E _____

ECBC – Edgewood Chemical Biological Center, US Army

EOD – Explosive Ordnance Disposal

EOSTI- End-of-Service-Time Indicator

ESLI – End-of-Service-Life Indicator

EPA - Environmental Protection Agency

F _____

FFPE- Fire Fighter Protective Ensemble (Commonly known as Bunker Gear or Turnout Gear.)

G _____

GB- Sarin, G-series nerve chemical warfare agent

H _____

HAZMAT - Hazardous Material

HAZWOPER - Hazardous Waste Operations and Emergency Response

HD - Blister, H-series distilled sulfur mustard chemical warfare agent

HHS - Department of Health and Human Services

HUD – Heads-Up Display

I _____

IAB – Inter-Agency Board for Equipment Standardization and Interoperability Working Group

IDLH - Immediately Dangerous to Life or Health

IED – Improvised Explosive Device

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IND – Improvised Nuclear Device

ISEA – International Safety Equipment Association

L _____

LANL – Los Alamos National Laboratory

LAT – live agent test

LED - light emitting diode

LRPL - laboratory respirator protection level

M _____

MUC – maximum use concentration

N _____

NBC - Nuclear, Biological and Chemical

NFPA - National Fire Protection Association

NIOSH- The National Institute for Occupational Safety and Health

NIST - National Institute for Standards and Technology

NPPTL- National Personal Protective Technology Laboratory

O _____

OSHA – Occupational Safety and Health Administration

P _____

PAPR – Powered Air-Purifying Respirator

PASS - personal alert safety system

PEL – permissible exposure limit (OSHA)

PPE – personal protective equipment

PSIG – Pounds force of pressure per Square Inch Gauge (excluding atmospheric pressure)

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Q_____

QLFT - qualitative fit test (for a respirator)

QNFT - quantitative fit test (for a respirator)

R_____

RDECOM - Research, Development and Engineering Command, US Army, formerly SBCCOM

REL- recommended exposure limit (NIOSH)

RIC/UAC - Rapid Intervention Crew (Company)/Universal Air Connection System

RIT – Rapid Intervention Team

RKB – Responder Knowledge Base

S_____

SBCCOM— Soldier, Biological, and Chemical Command, US Army

SCBA - Self-Contained Breathing Apparatus

SCER – Self-Contained Escape Respirator Industrial version is **ESCBA** for Escape SCBA

SEI - Safety Equipment Institute

SLUDGE – Salivation, Lacrimation, Urination, Defecation, Gastro-intestinal distress and Emesis

SMARTMAN - SiMulant Agent Resistant Test MANikin

SWAT – Special Weapons and Tactics

T_____

TIC - Toxic Industrial Chemicals

TIM - Toxic Industrial Materials

U_____

UI – User Instructions

V_____

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VX- VX, V-series nerve chemical warfare agent

W _____

WMD – weapon(s) of mass destruction

Note: The acronyms listed are select terms expected to be commonly used in CBRN incident response. The list is not designed to be all encompassing. All or some of the acronyms have the potential for use during CBRN incidents, however, lead federal agency policies and guidance in effect at the time of incident response and recovery are expected to carry precedence.

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Acknowledgments

To Be Published

CHAPTER 1: Background, Rationale and Design Requirements

A. Background and Purpose

The purpose of the guide is three fold. First, the guide is intended to assist individual respirator wearers, tactical leaders, deployed squads, emergency response teams, respirator program administrators and supervisors in recognizing NIOSH-approved CBRN SCBA from traditional NFPA compliant SCBA or NIOSH-approved industrial SCBA. Second, educate these end-users on the applicable cautions and limitations of a CBRN SCBA so they know, upfront, the CBRN SCBA will not be the all encompassing magic bullet to a CBRN response. And thirdly, provide use recommendations in the form of cumulative best practices most likely to contribute to life-saving actions before, during and after a CBRN incident response. This is a user's guide intended to be updated as relevant real-world events occur and as technology advances or standardizes.

The guide provides recommended actions for clearly identifying newly purchased CBRN SCBA, inspecting field deployed SCBA upgraded to CBRN protection (retrofitted) and developing use-life criteria for contaminated CBRN SCBA. Recommendations for how to assess SCBA for NIOSH CBRN compliance, how to differentiate between NIOSH CBRN approved SCBA and NIOSH industrial approved SCBA or NFPA compliant SCBA, how to prepare respirators for CBRN response, how to use respirators in potential or known CBRN incidents and recommendations on how to discard contaminated respirators in post-incident responses. It is practical guidance for the proper use of specific types of NIOSH-approved SCBA, which have passed NIOSH special CBRN requirements tests.

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Select or all portions are useful for respirator protection program administrators; however, most information is focused on how to assist emergency responders in identifying, maintaining, using and integrating CBRN SCBA. In the course of assisting responders in those tasks, information standardization of terms will likely occur and contribute to more efficient emergency operations center functions and ease of mission support. One example of multiple terms for the same type of equipment is the fact that some responders use the name "SCBA" for the open-circuit SCBA, while others use "BA", or "Air Paks" when referring to SCBA.

ATTENTION ALL EMERGENCY RESPONDERS OR OTHER TRAINED USERS: The sole use of a CBRN SCBA will not protect you from the effects of all or some CBRN agents. CBRN SCBA use must be in conjunction with appropriate full body skin protection. Expedient coverage of all exposed skin by the most expeditious method will help reduce the amount of agent a first responder is exposed to and ultimately the amount of debilitating acute or chronic effects. Proper use of a respirator is a complex process requiring the knowledge of how to properly select a respirator for a specific contaminant or environment, assuring its proper fit, and being aware of respirator use limitations. While the NIOSH intent is to integrate a respirator seamlessly into a level of integrated protection for a responder, conscious efforts must be made on the part of the end user to get the afforded level of protection from the respirator. The information in this guide is intended to be administered through a complete respiratory protection program under the Occupational Safety and Health Administration (OSHA) Respiratory Protection Standard and relies on the reader being properly trained and proficient [29 CFR 1910.134]. When a respiratory protection program is not in place, this guide will still serve as a reference for safe operations of a CBRN SCBA.

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The respirator protection program covers criteria for selecting respirators; medical evaluations; fit testing; use; maintenance, inspection, breathing air quality, cleaning, and storage; worker training; program logistics; and regular evaluations of program effectiveness. The respiratory protection program is directed by a designated knowledgeable professional (competent person), the respirator program administrator. The respirator program administrator oversees all aspects of the respirator program, interacts with management personnel and is available to the user as a resource for questions or concerns on respirator use. The guide is subject to continual review and update when facts change due to technology improvements or real-world event characterization. While the guide is intended for end users, as stated, it does contain elements that are ideally well suited for respirator protection program administrators to consider.

Information on the OSHA Respiratory Protection Standard [29 CFR 1910.134] is available at:

<http://www.osha.gov/SLTC/etools/respiratory/index.html>

B. Rationale: IAB, Inter-Agency Agreements (IAA) and Memorandums Of Understanding (MOU)

In October 1998, the Attorney General of the United States and the Department of Defense's Director of Military Support commissioned a first responder interagency board to develop methods to ensure personal protective equipment standardization and interoperability, to encourage the research and development of advanced technologies and to assist first responders at the state and local levels in

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establishing and maintaining a robust crisis and consequence management capability². The group became known as the IAB. It was supported by voluntary participation from various local, state, federal government and private organizations. Now formally called *The Inter-Agency Board for Equipment Standardization and Interoperability Working Group*, the IAB mission is to establish and coordinate local, state and federal standardization, interoperability, and responder safety to prepare for respond to, mitigate, and recover from any incident by identifying requirements for chemical, biological, radiological, nuclear or explosives (CBRNE) incident response equipment.³ The IAB accomplishes its mission statement by using committee consensus results and subgroup analysis techniques to generate generic equipment and CBRNE reference lists in twelve sections relative to PPE, explosive device mitigation and remediation equipment, CBRNE operational and search and rescue equipment, information technology, cyber-security enhancement equipment, interoperable communications equipment, detection, decontamination, medical, power (electrical), CBRNE reference materials and standards list.⁴

In 1999, the IAB initiated the quest to develop federal standards or guidelines for personnel protective equipment, with respiratory protection equipment as one of the top priorities. In response to this 1999 initiative, the National Institute for Standards and Technology (NIST), NFPA, NIOSH and OSHA entered into a memorandum of understanding defining each agency's or organization's role in developing, establishing, and enforcing standards or guidelines for responders' respiratory protective

² The InterAgency Board for Equipment Standardization and InterOperability 1999 Annual Report [1999]. The InterAgency Board for Equipment Standardization and InterOperability Consequence Management Program Integration Office, Office of the Director of Military Support, HQDA: 3.

³ The InterAgency Board 2004 Annual Report 2005 Standardized Equipment List [2005]. The InterAgency Board: 10.

⁴ Ibid., p.101-265

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devices. Subsequently, in 2001, the Centers for Disease Control and Prevention (CDC) and NIOSH entered into an Inter-agency Agreement 02-03, (IAA 02-03) with the United States Army, Soldier, Biological Chemical Command (SBCCOM/RDECOM) entitled *Testing Activities to Support Respirator Standards Development and Approval Testing*, which allowed multiple federal agreements. NIOSH is to collaborate with RDECOM on the establishment of test procedures for various classes of respirators for use by first responders to incidents of terrorism, provide RDECOM standard test procedures, and reimburse RDECOM for costs of conducting NIOSH laboratory tests. In return, RDECOM provides laboratory testing and administrative services for performance of NIOSH standard test procedures requested by NIOSH/NPPTL, RDECOM assures that RDECOM laboratory practices are documented and followed, provides NIOSH test reports for all required tests and collaborates with NIOSH on the establishment of new test procedures for various classes of respirators used by first responders to incidents of terrorism.⁵ The collaborative standards development and research efforts of IAA 02-03 resulted in the first NIOSH CBRN SCBA certification standard, dated December 28, 2001, the current ongoing CBRN SCBA certification program, and the current ongoing CBRN SCBA upgrade kit certification program. Information related to the CBRN SCBA standard and CBRN SCBA upgrade/retrofit kit letter is located at the following pasted links:

<http://www.cdc.gov/niosh/npptl/standardsdev/cbrn/scba/>

<http://www.cdc.gov/niosh/npptl/resources/pressrel/letters/ltr-031103c.html>

⁵ CDC [2001]. Inter/Intra-Agency Agreement. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, CDC (NIOSH) IAA # 02-03.

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C. Standard Development, Rationale and Analysis

The NIOSH National Personal Protective Technology Laboratory leads the development of a CBRN respirator certification program that bolsters U.S. emergency responder preparedness. Working with diverse business and federal partners, NPPTL expeditiously developed rigorous new standards for testing and certifying respirators for use by emergency responders in potential terrorist attacks. NPPTL established this new program to meet the perceived and potential emerging needs of all U.S. emergency responders after the events of September 11, 2001.

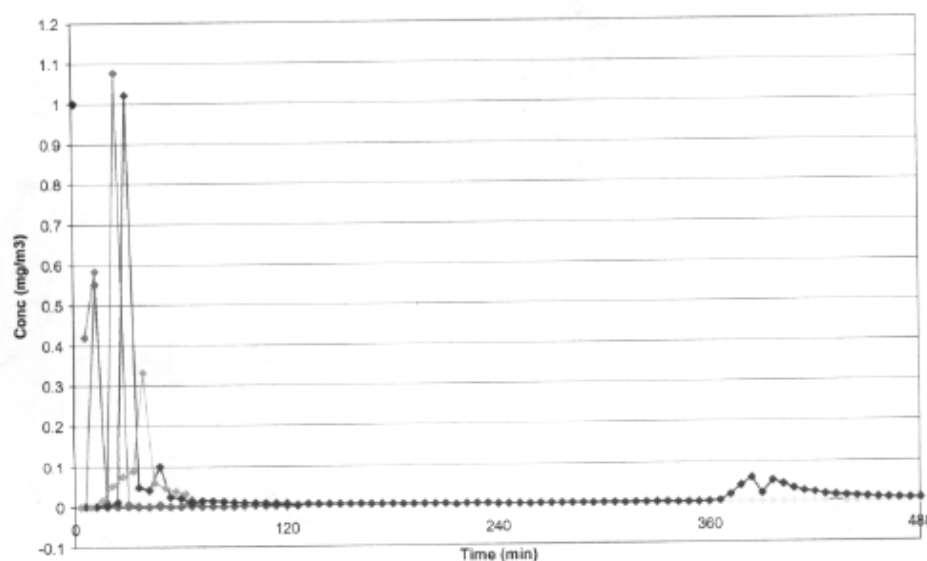
To determine the certification requirements for the CBRN SCBA, the following areas were defined and reviewed. First, a market survey of current SCBA technology was conducted by NIOSH, with the support of the International Safety Equipment Association (ISEA), in October, 2001. The survey resulted in NIOSH bench testing of available industrial, NIOSH-approved, and NFPA-compliant SCBA using existing US Army/RDECOM/Edgewood Chemical Biological Center (ECBC) chemical warfare agent (CWA) test methods. Second, a NIOSH policy review determined the applicability of current 42CFR Part 84 standards and NIOSH authority to implement new CBRN SCBA certification testing, by policy as opposed to formal law rule-making. Third, simultaneously, a hazard assessment of possible CWA incidents and physical hazards was collaborated and defined by NPPTL with RDECOM, while a corresponding analysis of human factor and CBRN special test protection requirements were written under the IAA and NIOSH standard test procedures developed and verified.

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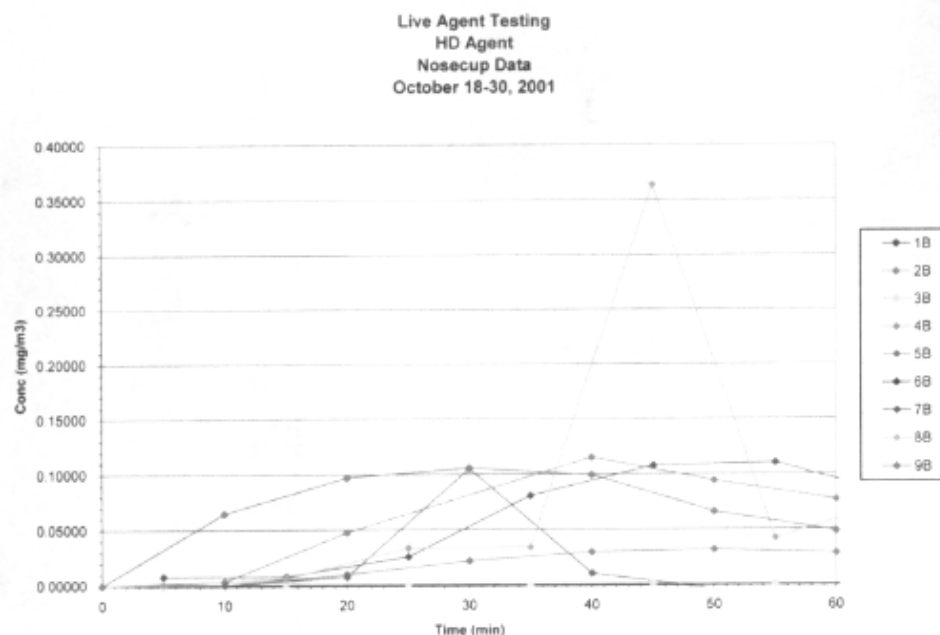
Figures 1 and 2 below are a sample of the generic graphs produced from the NIOSH-SBCCOM SCBA survey/bench testing. A debrief was conducted with respirator manufacturers. Each respirator manufacturer that attended the NIOSH debrief on this survey was provided their own proprietary binder of the test results specific to their SCBA. A sample of what the stakeholders were provided is shown in Figures 1 and 2 below. Figure 1, GB, shows the available GB nose-cup data generated from the RDECOM test methods for live agent testing of 9-off the shelf SCBA.

This data and numerous other observations such as catastrophic destruction due to liquid/aerosol HD permeation of air pressure boundaries and breathing zone saturation from GB provided bench test evidence and rationale for NIOSH to fast track the development of CBRN SCBA standards that would increase the protective quality of these SCBA against chemical warfare agents and particulates.

SCBA Bench Testing with Live CW Agent
GB, SMARTMAN Nosecup Data, One MINICAM, 120psi
October, 2001



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Figures 1, GB, and Figure 2, HD. NIOSH and SBCCOM SCBA Survey experimental data

A joint NIOSH/NPPTL and RDECOM CBRN hazard assessment considered agent physical chemistry characteristics and use of potential terrorist target modeling techniques to generate contamination concentration profiles for the potential hazards at an incident involving CWA. For these assessments, the means of delivery and dissemination of the CWA were considered, combined with other variables including the amount of CWA employed and the environmental and physical characteristics of the area where the incident may occur. This threat analysis and the inclusion of toxicological acute exposure guideline level (AEGL) values were incorporated into test requirements, and resultant pass/fail values, and requirements of the CBRN SCBA standard test procedures.

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Coupling the threat analysis with the policy definitions of 42 CFR, Part 84, sub-paragraphs and the fire safety compliance inspections of the NFPA testing laboratories, NIOSH generated a CBRN SCBA certification standard that revolutionized the SCBA manufacturing industry and demonstrated a higher standard of protection. A CBRN SCBA has a triple level of approval review consisting of 42CFR, Part 84, 13F respirator class requirements, NFPA 1981, current edition, compliance review/testing and NIOSH special CBRN tests, resulting in a device that provides a higher degree of inhalation protection against a multitude of hazards while using current available technology. The adoption of the triple level of approval became known as the "Three-Tier Approval Process".

1) Three-Tier Approval Process

NIOSH established the enhanced performance and design requirements for certification as a three-tier approval program designed to meet the identified respiratory protection needs, current environmental use conditions of emergency responders, and predicted civilian hazard exposures based on a variety of exposure scenarios ranging from open air to confined space. Confined space was determined as the worst case scenario with the possibility of concentrated chemical warfare compounds, lower explosive limits (LEL), varying oxygen levels, and displaced oxygen concentrations.

- Tier 1— Industrial approval for the program ensures the SCBA meets current NIOSH approval requirements for an SCBA under NIOSH 42 CFR part 84, Subpart H. The CBRN SCBA certification program utilizes the vast amount of experience NIOSH has in

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- approving technical certification number (TC-) 13F approvals in the occupational workplace under NIOSH 42 CFR84, Subparts H and L. Tier 1, or the first tier of the approval, ensures the CBRN SCBA meets existing NIOSH industrial 13F minimum SCBA performance requirements to Subpart H. The CBRN SCBA candidate is required to attain Part 84 approval prior to being submitted for NIOSH CBRN protection testing. Part 84 compliance review by NIOSH is conducted in the initial review of the new extension for CBRN SCBA approval application.
- **Tier 2**— The second tier is a compliance certification of the SCBA by an independent third party qualified testing organization to *NFPA 1981, Standard on Open-Circuit Self-Contained Breathing Apparatus for Fire and Emergency Services, current edition. NFPA 1981* contains critical SCBA performance requirements unique to firefighting and operations in hazardous environments [NFPA 1981, edition 2002, effective August 8, 2002]. As the consensus standard for SCBA equipment used by the U.S. Fire Service, compliance with NFPA 1981 protocol ensures the CBRN SCBA can withstand routine structural fire hazard exposure while still maintaining minimum CBRN protection qualities- a protective quality deemed necessary in any explosive terrorist device incident. NFPA compliance testing for the program incorporates the enhanced performance requirements of the *NFPA 1981* standard including higher minimum flow rates and improved breathing resistance. *NFPA 1981* testing simulates SCBA use conditions through environmental exposures including high and low temperature conditions, heat and flame exposure, accelerated corrosion, particulate exposure, and vibration. Lens abrasion and

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communications (i.e., speech intelligibility while wearing the SCBA) are additionally evaluated. These critical systems tests show how the NIOSH CBRN SCBA approval is interwoven with existing standard setting organizations and utilizes the best of available technology to provide a higher level of combined protection.

- **Tier 3**— The third and final tier consists of three detailed and rigorous NIOSH CBRN Special Tests; 1- Sarin/GB Live Agent Testing (LAT), 2- Distilled Sulfur Mustard/HD LAT and 3- Corn Oil-Laboratory Respirator Protection Level (LRPL) Testing. GB and HD LAT involve direct exposure of the entire candidate CBRN SCBA, minus cylinder, to select chemical warfare agents. LRPL testing fit factor testing. It involves independent human test subjects self-donning adapted SCBA facepieces and maintaining an acceptable laboratory protection level against corn oil particulates. A NIOSH and RDECOM human subject review board (HSRB) approves the use of federal employees as human test subjects contaminated/exposed to corn-oil (cooking oil). (ADD Footnote on current HSRB protocol)
- These CBRN special tests for the program incorporate requirements resulting from an extensive effort to identify the hazards a first responder is likely to encounter and to define laboratory levels of respiratory protection required for the first responder.
- Live agent testing uses a pre-screening process on the SCBA by first exposing the respirator to instrument called a TDA-99M Particulate Generator. The TDA-99M uses non-toxic oil aerosol to check for gross air pressure boundary leaks. If the SCBA passes the pre-screening TDA-99M process, the SCBA system is deemed qualified to be mounted on the

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- SiMulant Agent Resistant Test Manikin (SMARTMAN) head form which is placed in the live agent test chamber. While on the live agent exposure platform test box, another TDA-99M procedure is done to verify sealing and confirm air pressure boundary properties are intact on the headform prior to agent exposure. The CWA Sarin (GB) and Distilled Sulfur Mustard (HD) are then used to evaluate the CBRN SCBA protection of the breathing zone on a static manikin head form breathing at a cyclic rate and the resistance of the SCBA systems and accessories to agent penetration and permeation.
- Once all the LAT are complete, a NIOSH NPPTL Laboratory Respirator Protection Level (LRPL) test is conducted based on the number of specified sizes of facepieces designed by the respirator manufacturer. LRPL particle size exposure utilizes 11 specific end user tasks that each human subject must perform successfully while wearing and maintaining a seal. LRPL test trials (2 per test subject) evaluate the performance of the identical tested facepiece only with its mounted accessories and not the entire SCBA as per current U.S. Occupational Safety and Health Act (OSHA) quantitative fit test procedures. The facepiece is adapted by using a manufacturer specific negative pressure adapter and particulate filtration media. This adapted facepiece is then self- donned by a specific number of human test subjects and evaluated per the NIOSH LRPL standard test procedure. These special CBRN tests are implemented by policy, not rulemaking, under the provisions of 42 CFR Part 84, paragraph 84.63(c):

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- a) Live agent tests measure CWA permeation and penetration resistance against Sarin vapor (GB) and sulfur mustard (HD) liquid and aerosol. These compounds are actual chemical warfare agent, commonly known as "live agent", as opposed to simulated agent or training agents, and they are used to gain maximum assessment of the respirator against the unique penetration properties of GB liquid aerosol and the caustic permeation properties of HD liquid aerosol and HD liquid droplets.
- b) The laboratory respirator protection level (LRPL) test helps NIOSH and NPPTL to determine the degree of fit a given respirator faceblank allows and whether or not that faceblank, and the size range marketed by the manufacturer, can fit a wide range of facial sizes based on an accepted Los Alamos National Laboratory (LANL) face size panel of distribution. Essentially, the LRPL fit trials ensure that the facepiece seal (the interface between the user and the SCBA facepiece), quantitatively demonstrates an acceptable fit factor ratio of greater than 500 on a panel of human test subjects. The human test subjects are assessed per a human subject review board (HSRB) protocol and are intended to approximate 95% of the facial sizes of a given user population.

How does this relate to the NIOSH approval sought by equipment purchasers in the competitive bid processes of selling respirators? If the respirator fails a specific number of CBRN tests it does not get approved. It is that simple. Administratively, there is a process in

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place to track the test status, and NIOSH uses that process to lead the civilian respirator global market place. It a public electronic application process called the SAP.

The certification of respirators per the administrative standard application procedure, or SAP, for compliant approval holders is complex and difficult for the novice. For the purposes of CBRN approvals it can be simplified to the following information. A NIOSH administrative review of tested part numbers, showing passing results under Tier 3 is conducted during the final review of the application. This is done against the part number listing showing compliance to NFPA 1981. If any part number changes, material changes or air-pressure boundary changes are made to allow the SCBA to pass CBRN testing, the passing configuration assembly matrix review done by NIOSH NPPTL federal examiners compare the listing and generate status of the review (Number of misses or a clean review). The final passing configuration assembly matrix is then reviewed by the NFPA testing agency (SEI, in this case) and NIOSH NPPTL for final NFPA compliance and NIOSH NPPTL compliance certification. All part numbers must demonstrate NFPA compliance and NIOSH CBRN test compliance or be removed from the NIOSH CBRN SCBA assembly matrix prior to the issuance of a NIOSH CBRN SCBA approval letter by NIOSH.

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2) CBRN SCBA is Dual Purpose.

The only certainty to a terrorist event-is the uncertainty of the type and pervasiveness of hazard. In most explosions, fire hazards are normally initially present. If a CBRN agent is dispersed in an improvised explosive device (IED) or vehicle borne detonated munition, fire hazard protection as well as chemical warfare agent protection is provided by the NIOSH-approved CBRN SCBA. Traditional NIOSH-approved SCBA do not have this fire resistance or chemical warfare agent protection.

Firefighters, emergency medical technicians and explosive ordnance disposal (EOD) specialists are examples of SCBA end users that benefit from the 2d Tier of the NIOSH CBRN approval process – National Fire Protection Association (NFPA) certification and NIOSH final compliance review of candidate NIOSH CBRN approved SCBA. However, law enforcement responders, while needing fire resistance; do not need noise and light discipline compromised by dual redundant alarms of a NFPA 1981 compliant SCBA. A unique NIOSH-approved CBRN SCBA standard for law enforcement responders is needed.

If a first responder wants to obtain the specifics on CBRN personal protective equipment (PPE), how to procure the equipment by line number and the marketing endorsements available, the responder can contact a respirator manufacturer, contact NIOSH, or log on to the NIOSH Certified Equipment Listing (CEL) or the DHS funded, Responder Knowledge Base (RKB), search engine. The RKB search engine is a popular tool available to grant writing local and state officials seeking federal homeland security grants. The RKB search

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engine is provided by the National Memorial Institute for the Prevention of Terrorism (MIPT) and is located at <http://www1.rkb.mipt.org/>.

a. **Life Saving Features**

Unlike industrial workplace environments where hazards are characterized and expected to be controlled, hazards at a terrorist event are expected to be initially, or subsequently, unknown or masked, and likely to be uncontrolled during the initial emergency response. First responders in an emergency response workplace, may encounter more, to extremely more, severe hazards than those normally encountered in either industrial, civilian emergency response or low intensity military settings.

The NIOSH-approved CBRN SCBA provides the wearer with respiratory protection in potential, known or unknown hazardous settings or environments. It may be used for entrance into and escape from atmospheres that are immediately dangerous to life and health (IDLH) or oxygen deficient. All NIOSH-approved CBRN SCBA listed on the NIOSH website are NFPA and NIOSH CBRN compliant and may be used for traditional industrial hazardous material, fire-fighting, CBRN/WMD incident response or all three. Buyers beware though! Not all components or accessories offered by respirator manufacturers are NIOSH-approved for use on the NIOSH CBRN SCBA. Users should check with the manufacturer representative and check the NIOSH approval label for the rigorous fact finding mission of confirming a part number of a respirator is NIOSH-approved and carries CBRN protection compliance. The approval label

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is white printed paper and it is required to be inserted in the user instructions/manual for the SCBA.

If users are really serious about knowing capabilities of a NIOSH-approved CBRN SCBA, all users should be trained on how to interpret the approval label and be familiar with the numerous part numbers that make up an approved CBRN SCBA configuration. All of the part numbers, when fitted together in a specific design, create life saving features and benefits. Examples of these life saving/mission support features are the heads-up display (HUD), redundant, dual, and primary air-pressure gauges, PASS device, communications devices, cylinder neck valve assemblies, cylinder types and respirator end of (remaining) service time indicators (EOSTI). These features on a NIOSH-approved CBRN SCBA respirator provide the user with situational awareness of SCBA operation before, during and after use. Additional life saving features are the Rapid Intervention Crew (RIC) fittings and by-pass purge valves. The technical details describing the HUD, Air pressure gauges, EOSTI, RIC UAC/RIT Fitting, By-Pass Valves and Cylinder Valve Interchangeability are as follows.

Heads-Up Display (HUD)

The HUD is a design requirement for NIOSH CBRN SCBA compliant to NFPA 1981, 2002 edition. The heads-up display, HUD, is visible to the wearer when the respirator is donned and operational. Depending on the type of HUD technology in use, a HUD can be mounted inside or mounted outside the facepiece. Its visible display shows cylinder pressure, system status and alert signals in the form of Light Emitting Diode (LED) color readouts or other signal devices.

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At the minimum, the HUD will display the remaining quantity of breathing air, a measure of real time cylinder pressure, and alert the user when the remaining quantity of breathing air reaches 50% full. Power sources for the HUD are usually electronic.

When batteries are used in the HUD, an alert showing battery life, remaining at 2- hours, is a requirement feature. Wireless remote HUDs or HUDs with integral wiring are also in the market and the wiring is tested for strength and effectiveness. Currently, NIOSH-approved CBRN SCBA are compliant to the NFPA 1981 code, 1997 edition *or* the NFPA 1981 code, 2002 edition. The HUD is present only on NIOSH-approved CBRN SCBA, NFPA 1981 code, 2002 edition, SCBA respirators. .

Gas or Air Pressure Gauges

Pressure gauges indicate the quantity of breathing air remaining in the cylinder. Pressure gauges are required to be redundant and to be visible to the wearer at all times. The primary air pressure gauge can be a mechanical gauge that operates with the pneumatic air pressure of the SCBA or as a visual signal continuously displayed as part of the facepiece heads-up display.

EOSTI: End-of-Service-Time Indicator(s)

End of (remaining) service time indicators (EOSTIs) are required to alert the user when the cylinder is low on air. EOSTIs consist of either an audible alarm (whistle); a visually flashing LED light in the heads-up display of the facepiece; or a vibrating alarm. Depending on the edition of the NFPA 1981 requirement that was current during the year the CBRN SCBA was

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approved, some units could have more than one independently operating EOSTI, each of which will be recognized by different human senses. Activation of the alarm of each EOSTI shall be independent of any other EOSTI, per NFPA 1981, 2002.

RIC UAC or RIT Fitting

The rapid intervention crew/company universal air connection (RIC/UAC) male fitting also known as, RIC/RIT fitting, is an air connector that transfers or replenishes breathing air to the SCBA breathing air cylinder without the user having to remove the cylinder from the SCBA harness assembly. The RIC fitting is only a design requirement for CBRN SCBA approved under the NFPA 1981, 2002 edition. It is not present on NIOSH-approved CBRN SCBA certified under the NFPA 1981, 1997 edition.

By-pass Valves for Use in the Event of Regulator Failure

High-pressure air from the cylinder is reduced as it passes through a first stage regulator and then a second stage regulator and finally the high-pressure air is reduced to a variable low pressure volume of air that is delivered to the facepiece at a rate determined by the physical demands of the user while attempting to maintain a positive pressure within the interior of the facepiece. NIOSH approval requirements specify that the regulator must fail "open" or allow the continuous flow of air into the facepiece or be equipped with a manual by-pass valve that will override the failed regulator in the event the respirator's regulator fails "closed". NIOSH testing requires that the SCBA second stage regulator fail in the open position. In the event that a second stage regulator fails in the "closed" position, required levels of air flow will stop to

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the facepiece. That failed second stage regulator can be manually "by-passed" by the user opening the by-pass valve, that is required to be colored red, to the purge/on position. Opening this red by-pass (purge) valve sends air flowing directly into the facepiece. Manufacturer's user instructions specify how to use the by-pass valve in the event of a regulator failure. By-pass valves expend pressurized air at a higher rate than the second stage regulator and will deplete the air cylinder at a more rapid rate. There are two types of by-pass valves: constant flow by-pass valves and a variable flow by-pass valves. By-pass constant flow valves are considered state of the art technology and commonly found on CBRN SCBA. Other types of by-pass valves, such those on belt mounted regulators of SCBA, currently do not have NIOSH-approved CBRN approval.

b. **SCBA System Rated Service Time**

A CBRN SCBA "System Rated Service Time" is the same time concept associated with the rated service time of an industrial SCBA. It is the length of time that an SCBA will continue to deliver breathing air to the facepiece at a specific use rate tested in accordance with 42 CFR Part 84. This is a reproducible laboratory "bench test time" and not equivalent to a human breathing performance time. Traditionally the system rated service times are 30, 45 or 60 minutes in the United States. They are determined during NIOSH testing of the capacity of the air cylinder. One analogy that is commonly used is to identify the SCBA rated service time by calling out the time value in minutes for a particular type of air cylinder/bottle. For example, select SCBA may be known as having a 30-minute bottle, a 45-minute bottle or a one-hour/60-minute bottle. The rated service time of a CBRN SCBA is located on the SCBA backframe

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harness in the form of an adhesive NIOSH approval label. The label color varies by SCBA manufacturer but its location is required and the information on it is also required in accordance with 42 CFR Part 84. That same rated service time is also explained in the NIOSH paper approval label inserted in the manufacturer's user instructions and on the official electronic NIOSH assembly matrix maintained by NIOSH-NPPTL.

A typical rated service time on an inserted approval label is listed under the protection column of the label and as an example, reads "SC/PD/CBRN 30 min/4500 psig". PSIG stands for Pounds Force of Pressure per Square Inch Gauge (excluding atmospheric pressure). This example translates to mean SC = Self-Contained, PD = Pressure Demand, CBRN is the additional protection category added, 30 min is the 30 minute rated service time at a 4500 psig. Different manufacturers may identify specific rated service times or pressure durations of SCBAs by unique names such as "4.5", "2.2", "3.0" or "L-30" etc. in the marketing names of the SCBA. The final rated service time of a CBRN SCBA is approved per the manufacturer's application request and the findings of NIOSH testing.

While time or rated service time, as it is formally called, is understood by the trained responder as the type of cylinder attached to the SCBA, such as 30-minute, 45-minute or 60-minute, the air pressure rating of those same cylinders is not always as easily understood. NIOSH does not approve a 90-minute rated service time in non-CBRN/industrial or CBRN open circuit SCBA. For example, an open-circuit, pressure-demand, SCBA, capable of mounting 30, 45 or 60 minute bottles may have a variable number of types of approved air pressures (4500 psig, 3000

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psig or 2216 psig) for those bottles/cylinders on one NIOSH approval label. With a few exceptions; 2216 psig rated cylinders are typically not used on a 60-minute rated service time SCBA and 4500psig rating is an example of a type of air pressure rating that can have all three types of rated service times in the form of different sized cylinders for a SCBA.

The NIOSH-approved rated service time of an industrial SCBA is typically based on air consumption at a moderate work rate and under laboratory conditions. This is also the case with the NIOSH CBRN SCBA. High work rates and differences in user lung capacity can significantly reduce or alter the actual service time achieved. As mentioned previously, CBRN SCBA rated service times are equivalent to the industrial rated service time ranges as per the first tier of CBRN approval for SCBA.

CBRN SCBA "actual service time" is usually less than the rated service time indicated on the label, due to the variables involving the physical condition of the user, the level of physical exertion, initial cylinder start pressure levels, ambient temperature of use, and other physical constant conditions. CBRN SCBA are not tested against live agents with the cylinder attached. Rather the appropriate cylinder valve, at the proper torque foot pounds of pressure, is adapted to a tooled adapter with pressurized air line interface that represents the pressurized vessel neck area. Live chemical warfare agent contamination in the six hour test duration prevents the quick fill or exchange of empty air cylinders with full air cylinders during the testing cycle and thus, air cylinders are not used for testing.

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c. **Cylinder Compliance**

Breathing air/gas cylinders used with SCBA hardware are classified as Air-Compressed, UN-1002, pressurized vessels, by the U.S. Department of Transportation. The DOT regulates the shipping, labeling, qualification, and periodic re-qualification of these pressurized vessels. Cylinders are tested and maintained as prescribed in 49CFR173 and 49CFR178, Shipping Container Specification Regulations, DOT. The respirator manufacturer can provide specific guidance on reading and interpreting the DOT markings on cylinders and how the hydrostatic test date markings are updated when a cylinder is re-qualified. OSHA requires that compressed breathing air for atmosphere supplying respirators, which includes the CBRN SCBA, must at a minimum, meet the requirements of Grade D breathing air described by the American National Standards Institute (ANSI) or in the Compressed Gas Association (CGA) Commodity Specification for Air, G-7-1, 1989 [OSHA 1910.134 (i), (1), (ii)]. The NFPA 1989, *Standard on Breathing Air Quality for Fire and Emergency Services Respiratory Protection*, 2003 Edition, is also a reference.

Interchangeable use of pure oxygen and breathing air is not permitted in the industrial approvals or the CBRN approvals for SCBA.

Quick charge, also known as "rapid fill/quick fill" is a process used to rapidly fill an empty air cylinder still mounted in the SCBA harness assembly while worn or unworn. Quick charge utilizes supplied air from a CGA compliant cascade air supply source and is done only at the explicit discretion of the fire scene or incident commander. Quick charge assemblies on CBRN

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SCBA are NIOSH approved as part of the CBRN SCBA air pressure boundary but not CBRN approved for actual use in a CBRN environment because the interfaces required for safely mating connections to air sources are not live agent tested, since that would involve certifying the air pressure boundary of another device that is not a respirator. Users should ensure all safety measures are enforced and practiced if quick charge operations are used. CBRN SCBA should be refilled in a prescribed air pressure refill operation procedure.

During cylinder recharging, numerous inspections of the cylinder and SCBA can be done as well. A CBRN SCBA user should inspect the air cylinder for the proper shape or roll of the cylinder, to ensure it conforms to what they know is correct, any unusual wear and tear indicators, discoloration from burns, cracks in the cylinder threads or cylinder neck valve housing or clogged holes in the burst disc/plug in accordance with the manufacturer's inspection procedures. A full cylinder is then attached to the SCBA hardware and the SCBA is checked for proper pressure reducing between regulators by conducting user function checks on the SCBA. Typically, the maintenance management of DOT hydro-static test dates and other related cylinder maintenance programs are controlled by the issuing fire department qualified technicians; however individual fire department standard operation procedures may require end users to physically check the hydro-static test date for expiration and process the cylinder for re-qualification. For those fire departments compliant to the codes of the National Fire Protection Association (NFPA), specific NFPA codes such as NFPA 1404 and NFPA 1500 require regular maintenance checks of the hydro-static test dates. Law enforcement departments that use SCBA or CBRN SCBA should have respirator manufacturer qualified

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officers conduct SCBA maintenance programs or rely on mutual aid support from local fire department resources.

Hydro-static test dates are labeled on air cylinders. New carbon composite cylinders rely on epoxy resin label updates readable on the body of the cylinder in the form of a three figure code. The three figure code, such as a "7 ^ 05" stands for the month number (7), followed by a unique inspector mark and then immediately followed by a calendar year two digit number (05). This means the cylinder is due for a hydrostatic test in July of 2005. Other cylinder materials such as aluminum cylinders rely on metal digit imprints in the neck cylinder area, very similar to the preceding described figure code example.

d. **Industrial Protection**

Traditional SCBA respirators used to fight fires or conduct law enforcement methamphetamine lab response are not adequate for CBRN incident responses. Traditional "Industrial protection" for respirators refers to industrial workplace respirators approved under NIOSH 42 CFR Part 84. This certification ensures the industrial SCBA meets existing minimum SCBA performance requirements consisting of maximum 35 lb weight, service life indicators, gas flow, service time, carbon dioxide, low temperature exposure, reliable use tests and human subject man tests. The CBRN SCBA program adapted the industrial protections protocol and used those same industrial proven test measures to insure initial compliance for the CBRN SCBA.

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CBRN SCBA are compliant to all industrial standards and are traditional open circuit, positive pressure or pressure demand, apparatus with additional special CBRN protections. CBRN SCBA are respirator devices in which the pressure inside the facepiece, in relation to the immediate environment, is required to maintain a slight positive pressure on laboratory head-forms during both inhalation and exhalation cycles.

While this positive pressure appears to be adequate for traditional SCBA used in industrial confined spaces, industrial hazardous materials response and firefighting, chemical warfare agents are not stopped by this positive pressure inhalation-exhalation cycle on regular industrial approved SCBA and thus are determined inadequate for CBRN incident response.

CBRN incident response has been referred to in the end user community as nothing more than "HAZMAT with an Attitude". NIOSH NPPTL CBRN respirator standards development and certification programs show that specific chemical warfare agents effects on non-CBRN protected SCBA and other respirators are more than the commonly known/expected hazardous materials effects on the same surfaces. Surviving a "terrorist grade" CBRN incident response will require that emergency responders use NIOSH CBRN approved respirators, use available live agent tested protective suits compatible with those CBRN respirators, be trained and have the situational awareness that provides entry and escape confidence under austere CBRN conditions designed to attack human physiology. CBRN hazards that are large in scale and severity will not just be a passing hazard that dissipates under routine environmental conditions. If and when they are used, military history and select civilian history tells the

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informed observer that CBRN agents will likely cause an emergency responder to heighten their attitude of response as opposed to the performance of the CBRN being adjusted to meet the expectations of a emergency responder.

e. Interchangeability of Cylinder Valves and Cylinder Assemblies on Different SCBA.

NIOSH CBRN SCBA approval is voided if another cylinder and cylinder neck valve assembly are attached to different manufacturer's SCBA hardware. However, in crisis response situations where OSHA requirements are waived, interchangeability between like cylinder valves and cylinder dimensions is achievable, provided a universal cylinder neck valve assembly is used. On November 23, 2004, the InterAgency Board for Equipment Standardization (IAB) requested the NFPA address the issue of how to make interoperability of SCBA cylinders a requirement of the NFPA 1981 code/standard. National Fire Protection Association is considering a change to the NFPA 1981, 2002 edition, authorizing interchangeability of a universal NFPA cylinder, yes, cylinder, and a cylinder neck valve assembly for all types of manufacturers seeking NFPA compliance. If the NFPA change is implemented, the use of an interchanged cylinder and cylinder neck valve assembly on a NIOSH-approved CBRN SCBA will void the NIOSH-approved CBRN approval in all current approved assemblies. Crisis response conditions may force incident commanders to rely on the available interchangeability of SCBA cylinders to meet mission constraints.

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1. Why have CBRN Protection on a SCBA?

The CBRN SCBA is not a one-time-incident SCBA when it is used in routine fire or hazardous material responses. CBRN SCBA are multipurpose in that they provide the same level of protection to the end user whether it is a structural fire, hazardous materials, "meth lab", riot control agent, chemical agent or biological toxin response. However, when it is a chemical agent response, such as GB or HD, CBRN SCBA are one time use respirators due to the known permeation and penetration characteristics of those agents and the inability of surface decontamination to neutralize the agent on the CBRN SCBA.

The fact that a respirator carries a NIOSH-approval for protection against CBRN agents and the fact that this specific type of respirator is being bought by emergency responders and civilians alike, may deter a terrorist from using or deploying a CBRN agent. To deter is to prevent or discourage from acting, especially by means of doubt or fear. A CBRN approved respirator creates psychological doubt that the planned effects of the CBRN terrorist incident will not achieve the expected result on a soft target like an emergency responder. History shows that chemical warfare agents are used on unprotected forces or civilian populations. The better prepared the emergency responder is the higher the deterrent value of the prepared emergency responder or responder community. Deterrence is the act or means of deterring and, in the state government arena, it is the measures taken by a state or an alliance of states to prevent hostile action by another state [Webster's, 2001]. Most public evidence points to the deterring effect of US nuclear and conventional weapons technology as deterrents that contributed to the end of the Cold War. Along this same perspective, acts of deterrence, such

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as those instituted by the US Department of Homeland Security, may contribute to the failure of international terrorism on US soil and perhaps abroad.

CBRN protected respirators currently contribute to the deterrence of CBRN acts of terrorism while increasing the national inventory of respiratory protective equipment available to crisis and consequence management responders for both industrial, fire and CBRN responses.

The US Department of Homeland Security National Response Plan (NRP) defines crisis management as predominately a law enforcement function and includes measures to identify, acquire, and plan the use of resources needed to anticipate, prevent and/or resolve a threat or act of terrorism. [NRP, December, 2004]. Conversely, the terms consequence management are viewed by the US Department of Homeland Security as predominately an emergency management function and include measures to protect public health and safety, restore essential government services and provide emergency relief to governments, businesses, and individuals affected by the consequences of terrorism. The requirements of consequence management and crisis management are combined in the NRP and therefore are not likely to be easily separated as they were during the New York World Trade Center response. [NRP, December, 2004, page 64] CBRN SCBA will perform to the same high standard regardless of whether the response is a crisis or consequence management incident timeline.

CBRN SCBA are significantly more complex compared to the engineering design requirements of CBRN air-purifying respirators. Numerous air-pressure boundaries exist in

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SCBA, and CBRN agents rigorously attack all respirator materials, air pressure boundaries and interfaces of that SCBA, as they do in an air-purifying respirator but to a lesser degree because there are less-parts in a CBRN APR. CBRN SCBA design requirements and technology have made rapid advances over the past three years to ensure that any given approved design allows the SCBA to provide the minimum amount of quantifiable breathing zone chemical agent protection, as determined under ideal laboratory conditions.

If there is air pressure disequilibrium due to respirator valve orientation, respirator valve material porosity or respirator material tooling design flaws, GB exhibits undefined chemical traits that allow it to penetrate and permeate the materials or flaws and attempt to create agent equilibrium between the interior of the respirator and the exterior GB concentration. The Venturi effect may account for why GB and HD penetrate between static and cyclic air-pressure boundaries of select respirators and, in fact, gain variable access to the breathing zone of a SCBA. Parameters of this same Venturi effect coupled with the dynamics of Bernoulli's Principle could explain why so called dead spaces, also commonly referred to as compartmentalized material chambers that do not see air pressure changes or air flow dynamics, allow GB to build up and actively penetrate/permeate or be flushed out by air exhalation cycles. This process of dead space air exhalation cleaning has been witnessed in NIOSH certification as one of the engineering design controls used to protect air pressure boundaries against GB penetration or permeation.

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It is a commonly understood phenomenon that GB aerosol will penetrate or permeate silicone surfaces that are used as respirator air valves or facepiece materials, provided there is minimal, to no, air flow/movement over the material surface. Government laboratory experiments confirm that various thicknesses of silicone swatches will allow permeation and penetration of GB, HD and VX, at various time intervals. While silicone is recognized as an ideal air pressure boundary for industrial use, its use in a CBRN approved respirator is limited by the fact that it allows agent to by-pass it. The amount of concentration gradient penetration that passes through silicone is dependent on the level of GB concentration, silicone material thickness and time of exposure. Of course, GB and HD hardened/resistant materials containing no silicone, blends of butyl and butyl appear to be ideal CBRN protection facepiece materials under ideal live agent laboratory conditions. Currently, silicone materials are common in many types of respirators and for select applications such as a biological agent response or a low grade chemical warfare agent response, silicone materials may still be used but will require insulation for protection against CWA affects.

Please remember that laboratory conditions cannot fully replicate actual CBRN use conditions of fire or law enforcement responses. However, they do replicate rigorous repeatable laboratory controlled CBRN SCBA exposures and allow the controlled observation and quantification of agent exposure affects and test results for NIOSH respirator certification purposes.

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Material surfaces that are treated may also be barriers to the affects of CWA. Hard non-porous surfaces, like coated polycarbonate, will allow liquid HD to drain off and will most likely not allow the surface to be permeated unless the HD agent is allowed to collect in a lip or threaded area. If the HD agent is allowed to collect or pool in an area of the respirator tests show that it permeates and grazes the material over time.

This is one of the reasons why timely gross decontamination with water of known CWA exposures shows repeatability in mitigating the permeation effects of select CBRN agents. Liquid HD is noted to aggressively attack thin plastic membranes, silicone membranes, stress points where two like or different materials interface and other porous surfaces causing pressurized points to violently expand, crack and physically crumble under slight external pressure or internal mating surface pressures.

CBRN protected respirators, tested and approved in a laboratory environments, are currently designed to protect against intelligence templated threat CBRN agents in what has been commonly referred to as "anticipated credible events". The terms "anticipated credible event" is confused with what is known as "worst case (use) conditions". Military grade CBRN agents are expensive to obtain, dangerous to handle and transport, and difficult to deliver by the moderately, or untrained, person. The existence of an effective protection program for emergency responders to respond to and control the hazard diminishes the potential impact of a CBRN attack and, consequently, may diminish the terrorist interest in investing time, energy and resources into this "mode" of attack.

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U.S. anthrax responses of autumn 2001 and other listed CBRN type events compiled and analyzed by the Monterey Institute of International Studies (MIIS), in 2001, show various degrees of credible chemical and biological terrorism attempted and executed in the U.S. and the international community.

In the case of chemical warfare agents, significant attacks initiated by the Japanese religious cult Aum Shinrikyo, now called Aleph, occurred from April 1990 to April of 2000 in Japan. CBRN agents of choice for the Aum Shinrikyo cult were VX, GB, variations of anthrax cultures and anthrax vaccine strains, variations of botulinum cultures, phosgene, hydrogen cyanide, sodium cyanide, sulfuric acid mixtures and hydrogen fluoride. The use of radiological agents by the cult, in the form of dirty bombs, was not identified by the MIIS 2001 assessment. However, MIIS did identify radiological incidents or "rad attacks" as termed by the MIIS that were planned and foiled.

CBRN agent physical constants (density, vapor pressure etc.) make them ideal inhalation threats and thus, the respiratory system is considered, by most scientists, as the primary route of entry into the human body followed by dermal exposure. Unprotected personnel have historically been the targets of chemical warfare agents or irritants. Irritants such as tear gas, the riot control agent CS, mace, pepper spray or some other irritant were sprayed in the first class cabin of the commercial jet American Airlines Flight 11 to apparently force passengers and flight crew toward the rear of the aircraft. [9/11 Commission Report, page 5, 2004]. The use of an irritant in the hijacking of American 11 shows the aptitude of the terrorist to

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understand the immediate effects of irritant particulate agents and the psychological outcomes resulting in intimidation and terror.

Integrating CBRN agents into a focused pre-planned terrorist attack is not expected to be easy for the terrorist, however, if the 9/11 attacks are indicators of terrorist planning capability and mission execution, the potential use of CBRN agents or riot control agents in future terrorism incidents cannot be discounted [<http://edition.cnn.com/SPECIALS/2002/terror.tapes/>].

CBRN agents may be one of the terrorist tools of primary or secondary choice in the next attack. CBRN protection, afforded by NIOSH CBRN SCBA, is the highest level of respiratory protection available. And when properly maintained, stored, and used it is expected to provide the level of protection for the life of the SCBA, as stated by the manufacturer, found compliant by the NFPA, and approved to a public standard by NIOSH. The types of CBRN agents are briefly discussed to show relevant caveats to use of the NIOSH-approved CBRN SCBA.

Toxic Industrial Chemical Agents

Airborne Industrial Chemicals, Toxic Industrial Chemicals, or Toxic Industrial Materials (TIC, TIM):

TIC and TIM are chemical elements, compounds or materials used in industrial applications that existing in the physical states as gases, vapors, liquids, solids, or particulate aerosols. The

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difference between a TIC and a TIM is physical state of the compound and whether the compound is mixed with other compounds or solitary.

Toxic Industrial Chemicals (TICs) are a variety of industrial chemicals used in civilian or military industrial processes which can kill, seriously injure, or incapacitate people if inadvertently released into the workplace or environment. The quantity of TIC and type of TIC determines downwind hazard evacuation or shelter in place emergency responder policies. Toxic industrial chemicals are normally bulk storage containers of solitary chemical compounds used to support industrial business in the manufacturing of a specific industrial product. Chlorine (CL₂) is considered a TIC despite its previous use as a classic chemical warfare agent during World War I. Anhydrous ammonia (NH₃) is also considered a TIC. These are just two of many TIC used in civilian industry. The US Environmental Protection Agency recognizes the acronym TIC as toxic industrial chemicals but does not define it further.

Toxic Industrial Materials (TIMs) are a variety of like industrial chemicals usually compatible together and used in civilian or military industrial processes which can kill, seriously injure, or incapacitate people. Toxic industrial materials are comprised of toxic industrial chemicals and are generally more than one select toxic industrial chemical making up a toxic industrial material. An example is the use of an industrial waste storage press that uses several toxic industrial chemicals routed to it for the purpose of generating a solid sludge waste as a toxic industrial material by-product for controlled disposal. Industrial sludge is a

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TIM. Industrial waste by-products transported in environmental waste roll-offs may also be considered TIM.

Examples are Chlorine, Anhydrous Ammonia, Phosphine, Ethylene Glycol Dinitrate, 1,1-Dimethylhydrazine, Acetylene, Butane, Cyclopropane, Ethylene, Methane, Propane, Gasoline, and Hydrogen.

Specific Chemical Warfare Agents (CWAs), Nerve and Blister Agents:

Nerve agents:

Examples are GB (Sarin), GA (Tabun), GD (Soman), GF (cyclohexyl Sarin), and VX. Nerve agents consist of a group of very toxic organophosphate chemicals specifically designed for military warfare. Most of the nerve agents exist as liquids, but some, such as GB, volatilize into the air on their own. GB in a liquid state has the consistency of water. It's name is derived from the four German scientists who invented it : Schrader, Ambros, Rudriger and van der L 'IN'de. [Library.thinkquest.org] VX, a persistent nerve agent and has a consistency similar to motor oil. It is not likely to become airborne, but in conditions involving explosions, it could aerosolize/vaporize and spread in the air. The introduction of "dusty CBRN agents" or "next generation CBRN agents" may warrant continued research into what level of protection a CBRN SCBA will provide to the wearer when exposed to these novel agents.

Additional information on nerve agents can be found at the following website:

NIOSH emergency response cards <http://www.bt.cdc.gov/agent>

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Blister agents:

HD (sulfur mustard), nitrogen mustard (HN-1, HN-2 and HN-3) and Lewisite (L, L-1, L-2 and L-3). Blister agents or vesicants are chemicals, which have severely irritating properties that produce fluid filled pockets on the skin and cause damage to the eyes, lungs, and other mucous membranes. HD is a liquid at ambient temperatures, but can vaporize on its own or be dispersed as a vapor in an explosion. HD, in the liquid state, permeates surfaces at the molecular level and can cause select materials to become brittle, break, or expand rapidly.

Additional information on sulfur mustard can be found at the following website:

NIOSH emergency response card for HD (sulfur mustard)

<http://www.bt.cdc.gov/agent/sulfurmustard/erc505-60-2pr.asp>

Biological Agents

Biological agents are particles and they will not penetrate the materials of properly assembled and fitted respirators or protective clothing. Some terrorism or state-sponsored devices may have the capacity to disseminate large quantities of biological agents or materials as aerosols. Biological agents may be dispersed in the form of liquid droplets, liquid aerosols, or solid aerosols, a powder of bacterial spores, for example.

The CBRN SCBA provides protection against airborne biological terrorists' threats including Anthrax, Brucellosis, Glanders, Pneumonic Plague, Tularemia, Q Fever, Smallpox, Venezuelan Equine Encephalitis, Viral Hemorrhagic Fevers, T-2 Mycotoxins, Botulism, Ricin,

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and Staphylococcus Enterotoxin B. NIOSH respirator policies state that under specific conditions, a properly worn and fitted traditional SCBA reduces the user's exposure to industrial hazards by a factor of at least 10,000. This reduction is true whether the hazard is from airborne industrial particles, industrial chemical vapors or industrial gases. CBRN SCBA are maintained to have that same minimum level of assigned protection plus enhanced material protection factors not inherent in traditional industrial SCBA. Other types of respirators, providing lower levels of assigned protection, are generally allowed in the workplace, once conditions are understood, defined and exposures are determined to be at considerably lower levels due to engineering controls, portable forced air ventilation or fitted PPE.

Additional information on bioterrorism agents can be found at the following website:

<http://www.bt.cdc.gov/agent/agentlist.asp>

Radiological and Nuclear Agents

Airborne particulate matter (liquid and solid aerosols) has the ability to carry radioactive particles with it (i.e., alpha and beta particles released from the atomic nuclei of an unstable isotope cling to dirt particulate). The CBRN SCBA provides protection from breathing this particulate-borne radiation by protecting against particles suspended in air.

Protection is not provided against high energy gamma radiation, which consists of the emission of photons from the atomic nuclei of a substance undergoing radioactive decay. Protecting responders from high energy gamma radiation requires minimizing exposure time,

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incorporating the use of special shielding garments, and maintaining appropriate distance from the source, based on the measured radiation exposure values at the site.

Protection is not provided against the explosive energy effects of a conventional or nuclear detonation creating energy blast waves and the resulting high velocity debris, which will likely impact the wearer and the respirator.

Radiological refers to particulate-borne radiation dispersed by detonation of a radiological dispersive device (RDD) or a radiological improvised explosive device (R-IED), also known as a “dirty bomb”. An RDD is understood to be a conventional explosive device that has been surrounded by or contaminated with some form of radioactive isotope material.

Nuclear refers to particulate-borne radiation dispersed by detonation of an improvised nuclear device (IND) or a nuclear warhead. An IND is intended to cause a yield-producing nuclear explosion, and could consist of diverted nuclear weapon components or a modified nuclear weapon. Unlike an RDD that can be made with almost any radioactive material, an IND requires fissionable material—highly enriched uranium or plutonium—to produce a nuclear yield.

Additional information on radiological and nuclear agents can be found at the following website:

<http://www.bt.cdc.gov/radiation/index.asp>

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2. Other Hazardous Atmospheres

Unknown Atmospheres

NIOSH approved CBRN SCBA are expected to provide protection against unknown toxic compounds and oxygen deficiency in unknown atmospheres. Air-purifying respirators (APR) of any type are not recommended in lieu of SCBA or Supplied Air Respirators (SAR) for these atmospheres. Go to the following link

<http://www.cdc.gov/niosh/npptl/topics/respirators/cbrnapproved/apr/default.html> to understand why a CBRN SCBA is recommended over a CBRN APR for use in unknown atmospheres or atmospheres that are expected to be high in toxic compounds. Unknown atmospheres are expected to be those atmospheres where the contaminant type and concentration is not known by the user prior to entry. A CBRN SCBA may be used for emergency or planned entry into unknown atmospheres provided the scene is secure and proper two-man entry rules are in effect per local incident command authority. Additionally, current CBRN SCBA are not required to be intrinsically safe and therefore, lower explosive limits (LEL) must be determined safe before entry.

Immediately Dangerous to Life or Health (IDLH) Atmospheres

NIOSH-approved CBRN SCBA provides protection against atmospheres at or close to levels considered immediately dangerous to life or health (IDLH). Under the *NIOSH Respirator Selection Logic, (October 2004)* and *NIOSH Interim Recommendations for Firefighters and Other First Responders for the Selection and Use of Protective Clothing and Respirators*

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Against Biological Agents, documents, one of the most protective respirators are self-contained breathing apparatus equipped with a full facepiece and operated in a pressure-demand mode. CBRN SCBA meets the criteria and is recommended for use in an IDLH atmosphere. This type of respirator is also selected for firefighting, entry into oxygen-deficient atmospheres, emergency situations, and entry into an atmosphere that contains a substance at a concentration greater than 2,000 times the NIOSH recommended exposure limit (REL) or OSHA permissible exposure limit (PEL) for a compound [NIOSH Pocket Guide, 2004].

The current NIOSH definition for an IDLH exposure condition is stipulated in the *NIOSH Respirator Selection Logic* [NIOSH Publication No. 2005-100]. Additionally, it can be found in the *NIOSH Pocket Guide to Chemical Hazards* <http://www.cdc.gov/niosh/npg/npg.html>.

In these documents, IDLH is defined as “an exposure condition that poses a threat of exposure to airborne contaminants when that exposure is likely to cause death or immediate or delayed permanent adverse health effects, or prevent escape from such an environment. The purpose of establishing an IDLH exposure level is to ensure that the worker can *escape* from a given contaminated environment in the event of failure of the respiratory protection equipment.

The IDLH is considered a maximum level above which only a highly reliable breathing apparatus providing maximum worker protection is permitted. Any appropriate approved respirator may be used to its maximum use concentration (MUC) up to the (known) IDLH concentration”. The original definition of IDLH was derived from 30 CFR 11.3(t) and the concept of incorporating a safety margin using standard completion program IDLH values

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were based on the effects that might occur as a consequence of a 30-minute exposure.

However, the 30-minute exposure was NOT meant to imply that workers should stay in the work environment any longer than necessary; in fact, every effort should be made to exit immediately.

Oxygen-Deficient Atmosphere

An oxygen-deficient atmosphere is defined by NIOSH as an atmosphere with an oxygen concentration below 19.5% by volume. The minimum requirement of 19.5% oxygen at sea level provides an adequate amount of oxygen for most work assignments and includes a safety factor. The safety factor is needed because oxygen-deficient atmospheres offer little warning of the danger, and the continuous measurement of an oxygen-deficient atmosphere is difficult.

Oxygen concentrations below 16% at sea level produces decreased mental effectiveness, visual acuity, and muscular coordination, and below 6% oxygen, death will result. Often only minor subjective changes as indicators are noted by individuals exposed to low concentrations of oxygen and collapse of the individual can occur without warning. Since oxygen-deficient atmospheres are life-threatening, only the most protective respirators are recommended. The most protective respirators are the pressure-demand self-contained breathing apparatus or the supplied-air respirators with auxiliary self-contained escape bottles for industrial operations and the CBRN SCBA for CBRN incident operations. See the respirator selection logic link at <http://www.cdc.gov/niosh/docs/2005-100/default.html> for further information.

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NIOSH recommends a supplied air breathing system to ensure adequate levels of oxygen for work in oxygen-deficient atmospheres. The NIOSH approved CBRN SCBA carries an independent supply of compressed gaseous breathing air that is not connected to a stationary breathing air source. A compressed gaseous breathing air supply is required by 42 CFR 84 to meet the applicable minimum grade requirements for gaseous air set forth in the Compressed Gas Association *Commodity Specification for Air, G-7-1*, 1966 (Grade D air or higher quality) publication. Compressed oxygen cannot be used in a device designed for compressed breathing air (an SCBA cylinder) and is not recommended by NIOSH. In fact, 42 CFR 84 prohibits certification of any device designed to permit interchangeable use of oxygen and air. It is a general practice safety rule that elemental oxygen can never be used in a device unless it is specifically designed for that purpose. Grade D or E air is also used in Self-Contained Underwater Breathing Apparatus (Scuba) which may be compliant to EN 14153-1 or EN 14413-1, in accordance with certification training programs endorsed or published by the Professional Association of Diving Instructors (PADI) (<http://www.padi.com/english/default.asp?o=am>)

3. SCBA Systems Checks

The manufacturer's user instructions (UI) gives detailed procedures for performing checks of components and accessories required on CBRN SCBA. Checks include an inspection of the material integrity for signs of wear or damage and an operational check of the function of the

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components and accessories. The manufacturer will specify in the UI what checks are necessary based on the components and accessories particular to that CBRN SCBA model.

Among the checks which should be performed before use are:

- a. Inspection of facepiece components and accessories
- b. Inspection of backframe and harness assembly
- c. Check of cylinder valve assembly function
- d. Check of cylinder gauge function and that it shows the cylinder is full
- e. Regulator function (both first stage and second stage regulators)
- f. Bypass valve function
- g. Function of all end-of-service-time-indicators (EOSTI)
- h. Function of heads-up-display (HUD)

NOTE: HUD is only a design requirement for NIOSH-approved CBRN SCBA under *NFPA 1981, 2002 edition*.

- i. Check of integrity of hoses for cuts, abrasions, cracks, heat and chemical damage, and that the hose connections are tight
- j. Check that the hydrostatic test date of the cylinder is valid and not expired
- k. Check function of personal alert safety systems (PASS) (if present)
- l. User seal check of facepiece and leak test of facepiece

4. SCBA Facepiece Fit Testing

Special Instructions concerning CBRN SCBA facepiece fit testing such as QNFT are provided as follows:

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NOTE # 1: PROPER TRAINING, SUPERVISED SCBA FACEPIECE FIT TESTING AND A PASSING FIT FACTOR FROM THE FIT-TEST ARE VITAL TO THE SAFE CONDUCT PERFORMANCE OF A NIOSH CBRN SCBA.

NOTE # 2: SUCCESSFUL FIT TESTING OF THIS NIOSH CBRN SCBA FACEPIECE IS REQUIRED PRIOR TO USE.

NOTE # 3: NIOSH DEFINES A "FIT TEST", PER THE OCTOBER 2004 RESPIRATOR DECISION LOGIC, AS *"FIT TEST: MEANS THE USE OF A PROTOCOL TO QUALITATIVELY OR QUANTITATIVELY EVALUATE THE FIT OF A RESPIRATOR ON AN INDIVIDUAL"*.

NOTE # 4: DO NOT CONFUSE FIT TESTING WITH A USERS FIT/SEAL CHECK. THEY ARE TWO DIFFERENT ACTIONS.

NOTE # 5: FIT TESTING IS REQUIRED IN THOSE RESPIRATORY PROTECTION PROGRAMS OF OSHA COMPLIANT STATES AND HIGHLY RECOMMENDED IN THOSE NON-OSHA STATE PROGRAMS.

NOTE # 6: FAILING FIT FACTORS FROM INADEQUATELY PERFORMED FIT TESTS OR INADEQUATELY SIZED FACEPIECES COULD CONTRIBUTE TO ADVERSE EFFECTS ON THE RESPIRATOR WEARER AND EVENTUAL POSSIBLE ACUTE OR

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CHRONIC LIFETIME EFFECTS UPON EXPOSURE TO CHARACTERIZED OR
UNCHARACTERISED TOXIC OR INCAPACITATING HAZARDOUS ATMOSPHERES.

NOTE # 7: USER FIT/SEAL CHECKS ARE ROUTINE SEAL CHECKS THAT ARE DONE ON A PROPERLY FIT TESTED FACEPIECE, WORN ON AN ASSIGNED END USER, TO ENSURE A PROPER FACE-TO-FACEPIECE PERIPHERY SEAL INTERFACE, AND A PROPER SYSTEMS FUNCTION CHECK SEAL IS ATTAINED AFTER INITIALLY DONNING THE FACEPIECE, AND AS NECESSARY, TO RESEAL THE FACEPIECE WHILE IN USE TO PREVENT INADVERTENT CONTAMINATION PENETRATION CAUSED BY THE FACEPIECE MOVING AROUND ON THE END USER'S FACE DURING ROUTINE USE OR INCREASED LEVELS OF USE.

NOTE # 8: SEE THE CBRN SCBA RESPIRATOR MANUFACTURER USER INSTRUCTIONS FOR ADDITIONAL INFORMATION ON FIT TESTING AND USER SEAL/FACEPIECE FIT CHECKS.

A respirator will not provide its intended level of protection unless it fits the user properly. A fit means that the periphery seals of the respirator facepiece conform adequately to the user's face while properly wearing the respirator. The fit assures a level of known protection, provided the facepiece is maintained properly and donned efficiently each time. Per conversation with experienced fire department personnel, fit testing is not one of the first actions a fire department does when a new SCBA is purchased. Routinely, the first action

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done on a new SCBA is to do a leak test. To ensure the fire department received a quality production model, most fire departments do SCBA system leak testing as a first time action on the new SCBA. As all SCBA systems meet expected manufacturer performance criteria from the leak testing, facepiece size allocation, selection and donning are usually done next followed by fit testing. The fit factor generated from compliant quantitative fit testing methods determines the success or failure of the fit testing.

NIOSH respirator selection logic defines a fit factor as a quantitative measure of the fit of a specific respirator facepiece to a particular individual. A fit-test is further defined as the use of a protocol to qualitatively or quantitatively evaluate the fit of a respirator on an individual (See also Qualitative Fit Test (QLFT) and Quantitative Fit Test (QNFT)). QNFT is defined as “Quantitative Fit Test (QNFT): Means an assessment of the adequacy of respirator fit by numerically measuring the amount of leakage into the respirator”. QLFT is defined as Qualitative Fit Test (QLFT): A pass/fail fit test to assess the adequacy of the respirator fit that relies on the individual’s response to the test agent. The QLFT and QNFT definitions are from the NIOSH Respirator Use Logic, dated 2004.

In the course of conducting a fit test, a defined and proven method is used to select a respirator size that provides the desired protective fit. Determination of facepiece fit is to be done by either a qualitative or quantitative OSHA-accepted protocol specified in Appendix A of the OSHA Respiratory Protection Standard [29 CFR 1910.134]. The respirator program administrator is responsible for providing fit-tests to respirator users prior to initial use of the

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respirator, whenever a different respirator facepiece (size, style, model or make) is used, and at least annually thereafter to ensure continued, proper fit [29 CFR 1910.134(f)(2)]. Users should also undergo fit testing when changes in their physical condition could affect respirator fit. Such conditions include, but are not limited to, facial scarring, dental changes, cosmetic surgery, or an obvious change in body weight [29 CFR 1910.134(f)(3)]. The OSHA Respiratory Protection Standard [29 CFR 1910.134] mandates that tight fitting facepieces, even for positive-pressure units, be fit tested in the negative pressure mode. This includes the NIOSH CBRN SCBA.

The user should have the option to try on different sizes of CBRN SCBA facepieces (small, medium, and large, for example) converted to negative pressure configurations. In addition to the industrial fit testing for traditional NIOSH 42 CFR 84 certification, human test subjects used in CBRN SCBA laboratory respirator protection level (LRPL) are quantitatively fit tested using quantitative calibrated particle analyzer machines to generate a LRPL value. In pre-LRPL trials, those individual that are hard to fit are tested on a TSI PORTACOUNT QNFT system to confirm the available size issued. Those same test subjects participate in the required corn oil chamber test trials during the LRPL testing phase. User seal checks are done by the CBRN SCBA test subject without assistance from a second person or expert fitter, known as "Self-Donning". Self donning and user seal checks are taught and trained in accordance with the most current manufacturer's user instructions. Facial hair, scalp hair lines, hair buns/tied up long hair or unshaven faces can contribute to inadequate fit testing results. Unshaven faces, hair lines that extend into the face-blank sealing area or hair buns that

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preclude the head harness from lying correctly, contribute to poor sealing characteristics routinely generate failing results. Consult your local industrial hygienist or safety officer/professional for technical assistance and training before attempting to conduct QNFT or QLFT

5. Facepiece Seal Leak Checks, User Seal Checks or Facemask Fit Checks

The user seal check is a method for determining whether a previously fit tested respirator has been properly donned and properly adjusted to ensure an adequate facepiece-to-face seal or fit. NIOSH respirator selection logic defines a user seal check as "An action conducted by the respirator user to determine if the respirator is properly seated to the face." Respirator users should perform a user seal check every time the respirator is donned and before entering a contaminated area. A user seal check evaluates the seal of the respirator to the user's face by having the user put the facepiece on under positive or negative pressure and noticing leakage. Effectiveness of the user seal check is dependent on the end user or assistant detecting any audible or visual changes in the respirator indicative of an air pressure boundary leak. User seal check procedures are located in Appendix B-1 of the OSHA Respiratory Protection Standard [29 CFR 1910.134]. Manufacturer's user seal check procedures, which are located in the manufacturer's user instructions specific to the model of respirator, are normally compliant with this OSHA reference. Specific respirator manufacturer user instructions may advise the wearer to conduct a 'facemask fit check'[Sabre SCBA User Instructions, March 2003]. This is the same as a user seal check. The facemask fit check is a unique process to the worn

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respirator, whereby the SCBA is fully donned, the cylinder valve is on, system charged and the wearer inserts two fingers into the mask face blank area to break the seal and check to determine if there is an outward flow of air (positive pressure). Once a sense of outward air is determined, under ideal conditions and with no CBRN contamination present the fingers are removed, and the faceblank is allowed to re-seal to the face. At this point wearers may be advised to stop breathing for a few seconds and check that there is no sound or air flowing from the second stage regulator. This method for checking the fit is more of an on site seal check and is not recommended for use in a toxic environment.

6. Accessories

An accessory is an item provided with a respirator that does not affect its ability to meet the NIOSH certification requirements of 42 CFR Part 84 [NIOSH SAP January 2001a]. CBRN approved accessories are listed as components of a respirator on the NIOSH approval label. However, in the case of CBRN protection approvals, submitted accessories must be attached and serviceable during the special CBRN LAT and LRPL trials. Batteries are not inserted in the integral or attached Personal Alert Safety System (PASS) devices because operation of the device does not expose SCBA air pressure boundaries to ambient air and therefore, not to test agents. CBRN SCBA accessories may include electronic voice amplifiers, affixed hardwire communications devices, spectacle (eyeglasses) kits, integrated PASS, stand alone PASS devices, fire service rescue belts and facepiece foam seal inserts.

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7. Upgrade of Field Deployed Units to CBRN Protection Approval

In 2002, NIOSH implemented a program to certify CBRN retrofit kits for field deployed SCBA <http://www.cdc.gov/niosh/npptl/resources/pressrel/letters/ltr-031103c.html>. SCBA units that were placed in service prior to issuance of CBRN approval may be upgraded to CBRN approval status through this program. Respirator users can contact the manufacturer of their current SCBA to see if a NIOSH-approved CBRN SCBA retrofit kit is available. Chapter 4, Section G. provides a detailed description of the requirements for approval upgrade of field deployed SCBA to CBRN protection.

Figure 3. Field deployed SCBA, minus cylinder, with CBRN SCBA upgrade kit attached and submitted for the NIOSH NPPTL initial review. Notice the red label denoting it is a CBRN rated model as well as the harness assembly labels of showing NIOSH approval.

Chapter 2. Certification Approval Factors

A. NIOSH Assembly Matrix

NIOSH CBRN SCBA part number configuration management is done by specific software that records, deconflicts, and compares numerous data files on a SCBA and generates a master part number and equipment description matrix maintained in proprietary confidence by NIOSH NPPTL. This assembly matrix is normally an electronic file that shows a table of major subassemblies and accessories assigned to a particular respirator. The assembly matrix is the technical parts data for the NIOSH approval label paper insert located with the manufacturer's CBRN SCBA user instructions. The January 2001 version of the NIOSH standard application procedures for the certification of respirators (SAP) defines an assembly matrix as a table of major sub-assemblies and accessories and should closely follow the format of the example shown in this manual in section C. This SAP version is under currently under revision for comment as Revision 2, February, 2005. In this SAP, a typical approved CBRN SCBA assembly matrix may list both industrial SCBA part numbers and CBRN part numbers or be a distinct and separate CBRN SCBA assembly matrix that simply tracks CBRN SCBA configurations at the discretion of the respirator manufacturer.

B. NIOSH Approval Label

Only respirators affixed with an adhesive CDC NIOSH CBRN Agent Approved label as shown below are certified by NIOSH for use in CBRN environments. To determine if a respirator is CBRN approved:

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- Look to see if the CBRN agent approved label is on the respirator, Figure 4. If a respirator is CBRN-approved by NIOSH, it will carry this adhesive label that has black and white lettering. The label is required to be located on the backframe of the SCBA in a highly visible location. If this CBRN agent approved label is **not** on the SCBA, the device is **not** approved by NIOSH for use in CBRN environments.
- **Check the CBRN agent approved label to avoid use errors! If the label is worn off or unreadable, contact the manufacturer for a replacement label prior to entering a CBRN incident response. Ensure that you read the user instructions for all required component part numbers, accessory part numbers and specific additional NIOSH cautions and limitations prior to use.**

Figure 4. SCBA CBRN Agent Approved Adhesive Label.

- Additional information is provided through the NIOSH, matrix-style approval labels (paper) found in the instruction manual for the respirator. The instruction manual is shipped by the manufacturer with the respirator. The instructions manual, operating manual, operations manual or, as it is generically known by NIOSH, User Instructions (UI), outline the general safety information, warnings, cautions, limitations, liabilities and special

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cautions and limitations for the CBRN SCBA as defined and endorsed by the manufacturer. These CBRN SCBA UI clearly state that use of the CBRN SCBA are intended for use by personnel who have successfully completed a manufacturer training program. In some emergency responder departments, SCBA are mistakenly not considered respirators and therefore not considered subject to respirator cautions and limitations. In these same departments, respirators are considered gas masks and SCBA are considered or known as just SCBA or BA.

- While manufacturer user instructions or operations manuals routinely refer to CBRN SCBA simply as, self contained breathing apparatus, SCBA are in fact, a separate class of respirators and not just simply self-contained breathing apparatus or breathing apparatus (BA).
- Separate classes of respirators in NIOSH routinely have separate technical certification (TC) approval numbers. The approval number or TC number for a SCBA respirator approved for CBRN protection includes a **CBRN** suffix (TC-13F-XXXXCBRN). The Xs are sequential administrative numbers assigned by NIOSH. **If the approval number does not include a CBRN suffix, it is not certified by NIOSH for use by emergency responders in CBRN environments.**
- **The complete CBRN assembly must be composed of only those component parts listed in the row with the CBRN approval number on the approval label (paper) located in the UI.** Each SCBA manufacturer has a unique part number for this approval label (paper

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insert label) and it is normally located in the lower right corner of the label. **Part numbers that are found in the rows of the non-CBRN approvals must not be used as part of a CBRN SCBA assembly.** Some manufacturers separate all the CBRN part numbers on a given matrix and others do not. **If the non-CBRN part numbers and the CBRN part numbers are inadvertently mixed and attached to SCBA hardware, the use of incorrect parts may cause death or injury.** Administratively and legally, this action voids the NIOSH original approval for that TC number. Many emergency responders may not actually ever see the NIOSH approval label that comes with the CBRN SCBA due to oversight or misplacement of the insert. See Appendix C for an example of a paper insert NIOSH CBRN approval label. Proper record documentation of the NIOSH-approved CBRN SCBA will contribute to sound fiscal policies in the authority of jurisdiction.

Figure 5. Actual Back Frame Assembly with CDC and NIOSH CBRN Agent Approved Label, NIOSH Abbreviated Harness Sticker Label and SEI Compliance Sticker Label Shown. All three labels are required for CBRN compliance.

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C. **NIOSH CBRN SCBA User Instructions (UI)**

User instructions specific to each CBRN SCBA are developed by the manufacturer for each unique model, reviewed by NIOSH for clarity, added to the final electronic assembly matrix, but are not necessarily listed on the inserted paper approval label found in the user instructions. Those manufacturer's users instructions describe procedures, such as, but not limited to, donning, fit, unit assembly, pre-checks for leakage, breathing air cylinder inspection and exchange, doffing, maintenance, cleaning, storage, and preparation for disposal. In all cases, the manufacturer's user instructions should be followed in accordance with local OSHA requirements and lead federal agency jurisdiction protocol.

D. **NIOSH CBRN Cautions and Limitations Paragraphs 2 and 3**

The subscript 2 and 3 refer to specific paragraphs on the NIOSH CBRN SCBA approval label.

Subscript 2 refers to the traditional NIOSH Cautions and Limitations associated with an industrial approved SCBA. Subscript 3 refers to special CBRN Cautions and Limitations applicable to the use of the SCBA under CBRN contamination. **In all cases, all cautions and limitations must be strictly followed. Cautions and limitations I, J, M, N, O and S apply when non-CBRN conditions of use are present. Cautions and limitations Q, R, T and U are additionally applied to I, J, M, N, O and S when CBRN conditions are expected, known or being decontaminated.**

E. **NIOSH Approval Life**

The life of a NIOSH CBRN SCBA approval does not expire unless the production of the CBRN SCBA is suspended and the manufacturer notifies NIOSH that the product has been discontinued.

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NIOSH then performs a controlled quality assurance action and physically deletes all relevant part numbers identified by the manufacturer as obsolete from NIOSH records. The approval number for the obsolete system still remains in the NIOSH system but the obsolete parts are no longer part of approved assembly matrices used for formal approval letters.

F. **NFPA 1981 Edition at Time of Approval**

CBRN SCBA must meet a compliance evaluation of the current edition of NFPA 1981 for *Open Circuit Self-Contained Breathing Apparatus for Fire and Emergency Services, Edition 2002* both before and after special CBRN tests. The *NFPA 1981* standard contains critical SCBA performance requirements unique to firefighting and operation in hazardous environments. *NFPA 1981* is the nationally recognized consensus standard for SCBA equipment used by the U.S. Fire Service. The enhanced performance requirements of the *NFPA 1981* standard include higher minimum flow rates and improved breathing resistance. *NFPA 1981* testing simulates SCBA use conditions through environmental exposures including high and low temperature conditions, heat and flame exposure, accelerated corrosion, particulate exposure, and vibration. Lens abrasion and communications (i.e., speech intelligibility while wearing the SCBA) are additionally evaluated. Carbon dioxide levels are also evaluated by NFPA 1981, 2002 edition, and the use of nose cups in SCBA is an end result of showing compliance to the 2002 edition.

Figure 6 . Cylinder Neck Valve Assemblies, minus Cylinders, in Preparation for CBRN SCBA (NFPA 1981, 2002) Upgrade Kit Application Processing. Battery is for PASS device.

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G. CBRN SCBA Retrofit/Upgrade Kits

On March 11, 2003, NIOSH began accepting extension approval applications for the evaluation of components and procedures to upgrade previously deployed (field-deployed) NIOSH-approved self-contained breathing apparatus to CBRN-approved configurations. The purpose of the program is to test and evaluate retrofit kits used to upgrade field-deployed SCBA, assure upgraded SCBA comply with approved CBRN SCBA configurations, and assure quality of the components and procedures, used to upgrade previous versions of the SCBA, establish the true CBRN-approved configuration. In addition to the NIOSH CBRN Agent Approved label, CBRN SCBA retrofit upgrade kits contain the replacement components, parts, materials, and operating instructions required to upgrade an existing SCBA configuration to the approved CBRN configuration.

The manufacturer's instruction manuals will provide a list of these components, and the retrofit application will contain the following:

- 1) The minimum technician qualifications for performing the retrofit, and the level of manufacturer training required
- 2) A list of SCBA types certified for use with the CBRN approved retrofit kit
- 3) Identification of the requirements for inspections and operational tests of the SCBA prior to performing the retrofit that are required to verify the SCBA complies with manufacturer quality and performance specifications for SCBA eligible to be retrofitted
- 4) Detailed procedures for replacing components, parts, and materials required to establish the CBRN SCBA configuration

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- 5) Guidance concerning the CBRN SCBA operating instructions and differences from normal SCBA operating instructions
- 6) Post retrofit inspections and tests required to verify that the work has been performed properly and that the CBRN SCBA operates in accordance with NIOSH, NFPA, and manufacturer requirements. As a minimum, the post retrofit inspection and test must verify leak tightness of assembly and components, positive pressure (static face-piece pressure), exhalation resistance, by-pass function, remaining service life alarm operation, pressure gauge accuracy, and flow performance
- 7) Directions for installation of the NIOSH CBRN SCBA Retrofit Approval label.

CBRN SCBA agent approved retrofit kits will contain a *NIOSH CBRN Agent Approved (retrofit)* label that must be affixed to the respirator after the upgrade is completed and the unit has passed the required post retrofit inspections and tests. Only if an SCBA retrofit kit is CBRN approved by NIOSH, will it be identified with a "NIOSH CBRN Agent Approved Retrofit" label. If the NIOSH CBRN Agent Approved Retrofit label is not present, the retrofit kit is not approved by NIOSH for use by emergency responders in CBRN environments.

Check the NIOSH CBRN agent approved retrofit label to alleviate use errors!

Figure 7. NIOSH SCBA CBRN agent approved RETROFIT Adhesive Label.

Chapter 3. Production Model Safety Markings

A. Unique CBRN Markings

CBRN SCBA may have unique markings for individual production models which are designed by the manufacturer. These unique markings, if present, are not required for NIOSH CBRN SCBA approval, but rather are present for the benefit of the user to ensure that CBRN tested components are installed on their CBRN SCBA or that CBRN SCBA are easily identified in the field when used or stored alongside non-CBRN approved SCBA.

Some examples of these markings are major re-designed facepieces, color-coded adhesive labels on the regulator or other components of the SCBA with printed letters *CBRN* on them. Some components may be embossed with the letters *CBRN* graphically printed. Other components may have the letters *CBRN* etched in specific visible components of the SCBA. Next generation use life indicators telling the amount and location of CBRN contamination on a CBRN SCBA and perhaps supporting protective ensemble equipment as well, should provide progressive engineering designs in this arena.

B. Unique Administrative Labels

CBRN SCBA have unique administrative labels provided by the manufacturer on the SCBA or in various forms of literature that accompany the SCBA. These unique labels provide written warnings, cautions, and informational statements on such topics, including, but not limited to:

- Indications of damage which would require a cylinder to be removed from service
- Training requirements for use
- Inspection

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- Maintenance
- Cylinder storage pressure, if the SCBA is out of service
- Recharging (filling) instructions
- Approved state of use only when compressed air reservoir is fully charged with air meeting the requirements of the Compressed Gas Association specification G-7.1 for Type 1, Grade D air, or equivalent specifications
- Use of adequate skin protection when worn in gases or vapors that poison by skin absorption for industrial use and all appropriate CBRN cautions and limitation statements and warnings
- In making renewals and repairs, parts identical with those furnished by the manufacturer under the pertinent approval shall be maintained
- Cautions to open valve slowly and to close valve after each use and when "out of air"
Cylinders should never be allowed to be truly empty.

C. Cautions and Limitations, Paragraph 2

The following NIOSH industrial cautions and limitations appear in Section 2 of that approval label paper insert and are identified with a superscript ² on the paper label.

- I -** Contains electrical parts, which have not been evaluated as an ignition source in flammable or explosive atmospheres by MSHA/NIOSH

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NOTE: Caution and Limitation 'I' will not be present on units which have met these evaluation requirements by MSHA/NIOSH

J - Failure to properly use and maintain this product could result in injury or death

M - All approved respirators shall be selected, fitted, used, and maintained in accordance with MSHA, OSHA, and other applicable regulations

N - Never substitute, modify, add, or omit parts. Use only exact replacement parts in the configuration as specified by the manufacturer

O - Refer to user's instructions, and/or maintenance manuals for information on use and maintenance of these respirators

S - Special or critical user's instructions and/or specific limitations apply. Refer to user's instructions before donning

NOTE: Caution and Limitation 'S' will only be on the NIOSH approval label if specified by the manufacturer in the user instructions. When 'S' appears on the NIOSH approval label, the corresponding Cautions and Limitations, that apply under 'S', will be explained in a designated section of the manufacturer's User Instructions (UI)

D. Cautions and Limitations, Paragraph 3

The following NIOSH cautions and limitations appear in Section 3 of the NIOSH approval label and apply specifically to use in CBRN environments. Cautions and limitations "T" and "U" deal with the limitations of use life in confirmed chemical warfare agent environments and determine the CRUL.

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- Q -** Use in conjunction with personal protective ensembles that provide appropriate levels of protection against dermal hazards
- R -** Some CBRN agents may not present immediate effects from exposure, but can result in delayed impairment, illness, or death
- T -** Direct contact with CBRN agents require proper handling of the SCBA after each use and between multiple entries during the same use. Decontamination and disposal procedures must be followed. If contaminated with liquid chemical warfare agents, dispose of the SCBA after decontamination
- U -** The respirator should not be used beyond 6 hours after initial exposure to chemical warfare agents to avoid possibility of agent permeation

E. Manufacturer's Warning and Caution Statements

The manufacturer's UI for each new production SCBA model may specify unique warning and caution statements specific to each model or type and its unique manufactured design. Examples of such statements are instructions related to "hatch air-way" type second stage regulators or "manual slide" or "push-in" type second stage regulators. The respirator training program should include instruction on understanding and training concerning the manufacturer specific warning and caution statements.

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F. Safety Default to Manufacturer's User Instructions

The manufacturer's UI are specific for each CBRN SCBA production model. Users should rely on the OSHA regulations with NIOSH recommendations and the manufacturer's UI as the best source of safety and use information for their CBRN SCBA. Users should also contact the manufacturer with specific questions if their concerns are not addressed in the UI or situations involving use are not addressed as noted in training or actual response.

G. Indicators of Chemical Agent Penetration

Specific chemical warfare agents, particularly HD, have the ability to cause catastrophic material failure of components and accessories which could cause injury or death to the user. Many CBRN SCBA components and accessories incorporate state-of-the-art hardened polymer material to protect against the aggressive nature of chemical warfare agents. CBRN SCBA have met laboratory test criteria against the chemical warfare agents GB and HD to measure penetration and permeation resistance of a fully operating CBRN SCBA system. However, it remains important for users to be aware of indicators of material failure of components and accessories in the unexpected event catastrophic material failure does occur unknowingly or knowingly. Laboratory testing has demonstrated that in industrial rated SCBA, GB seeks out crevices and dead space cavities and penetrates non-hardened surface interfaces or air pressure boundary materials such as silicone. HD has shown to be an aggressive permeating compound and attack specific plastic components of any exposed surface of the SCBA. Exposed components on facepieces that are under mechanical stress due to tension or internal valve or spring pressure are particularly vulnerable. Liquid HD, if allowed to stay on a flat material plastic surface can create grazing of the surface and may contribute to seal

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compromises. HD can cause brittleness and cracking to untreated polypropylene facepiece material or harness material. Users should inspect their CBRN SCBA when in a safe location and use safe handling procedures during use for any signs of material cracking, tearing, and component separation which could be caused from chemical warfare agent exposure. The traditional two man buddy system or rule is also recommended at this point to all emergency responders who normally operate in teams of two each, to assist in determining potential or actual visible indicators of CBRN agent effects on exposed surfaces of CBRN SCBA.

Indicators of agent penetration and permeation are quantified at the NIOSH level by certification graphs and data sheets assigned to a NIOSH task number. NIOSH live agent test results shown below are examples of quantitative test result indicators that graphically depict maximum peak values and Concentration over Time (Ct) values used in determining pass/fail criteria for issuing a NIOSH-approval letter granting CBRN protection to a SCBA type. The first graph (Figure 8) is a max peak graph and the second graph (Figure 9) is a Ct graph. Both are required for each agent trial conducted on a SCBA. The max peak LAT graph shows GB did penetrate and continue to stay in the breathing zone of the SMARTMAN mannequin for the duration of the six hour test.

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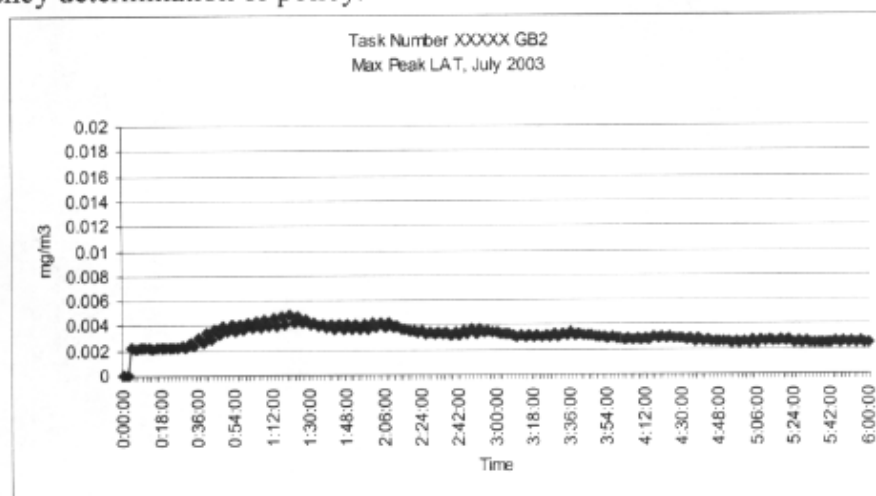


Figure 8, Max Peak GB Live Agent Test Result for Certification Task Number XXXX

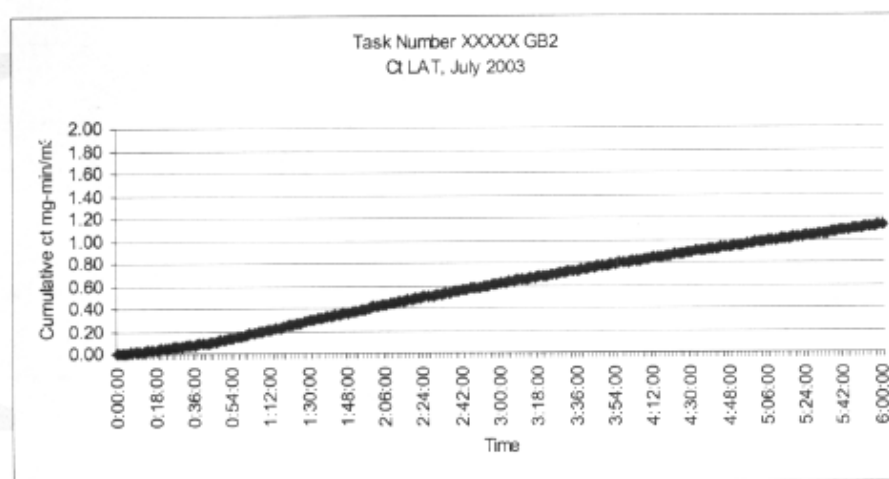


Figure 9, CT LAT test result for certification TN XXXX.

H. CBRN Respirator Use Life (CRUL)

A NIOSH CBRN SCBA has a 6-hour use life when exposed to chemical warfare agents. NIOSH NPPTL defines CBRN respirator use life as “NIOSH CBRN Respirator Use Life (CRUL) is a time value in hours or minutes, distinct for that specific type of CBRN respirator. The understanding and implementation of this time value is contingent upon the user understanding and adhering to NIOSH approved cautions and limitations issued at the time of the CBRN respirator approval. The use life time value incorporates a continuous use life beginning at the time of confirmed chemical warfare

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*agent exposure. This time **does not include** a variable time value that will be incurred as a result of decontaminating and disposing the CBRN respirator after its use life has expired. The use life concept is centered on a specific time value (X hours) generated from scientific data that repeatedly shows passing test criteria and results for the safe operation of the SCBA under strict laboratory exposures against GB (Sarin) and HD(Blister) chemical warfare agents at the specified NIOSH standard test procedure time requirement. CBRN respirator use life definition does not apply to respirator exposures against compounds or particulates that currently have NIOSH technical service life guidance in place, such as airborne particulates, provided the exposures do not degrade the air-pressure boundary or cause material surfaces of the CBR N SCBA to catastrophically destruct. If the unknown concentrations do cause the CBRN SCBA air-pressure boundaries or material surfaces to fail, the responder should egress to cleaner air, decontaminate, and doff the respirator per standard operation procedures. The implementation of a CRUL value is not applicable in this case and the destroyed respirator should be replaced, decontaminated and disposed.*

Confirmed CWA contamination presence is the key to determining the CBRN SCBA 6-hour start point of contamination. Therefore, instruments designed to detect, at stated concentration levels, are required to be on the incident site. Once detection confirms the agent type and quantity present, the CBRN SCBA use life of 6-hours starts. **The 6-hour use life means use is for 6-continuous elapsed hours in a single shift, day, or event. It does not mean 6-individual one-hour exposures in one shift or one day, nor does it mean six-different one-hour exposures, over the course of six-different days.**

CHAPTER 4. CBRN Respirator Use Life (CRUL) Time Value

Occupational safety and health requirements for emergency responders exposed to CBRN agents are expected to vary depending on several tangible factors. However, these factors have one dimension in common. They are all related around available **time**. The ten time tangible factors are as follows.

- 1) **Type of CBRN weapon employed**: Employed as or in aerial spray, bomblets, liter containers, 55 gallon drums, postal envelopes, packaged boxes, rail line conex dispersion, bulk food containers, vehicle borne improvised explosive devices, satchel improvised chemical devices, or as multiple types of agents simultaneously or sequentially deployed.
- 2) **Weather conditions and target geography at time of employment**: Variable factors such as changing air stability categories, before-morning-nautical-twilight weather conditions (BMNT), early-evening-nautical-twilight conditions (EENT), temperature gradients in air strata, wind speed at the surface and above ground, wind direction, daylight hours, nighttime hours, confined spaces, subterranean spaces, and urban, forested, inland or coastal regions
- 3) **Density of structures in targeted areas**: channeling effects of downwind hazard, open terrain, urban terrain, no structures, minimal structures, congested structures, low profile structures, high profile structures, evacuation routes in place, shelter in place actions rehearsed and available to the public
- 4) **Construction integrity of targeted structures**: Soft target, hard target, reinforced concrete command post, public restaurant, public venue, public transportation, mobile target, static target.

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5) **Concentration of CBRN agents deployed:** low level dispersion devices, high yield dispersion devices, liquid pools, dissipating vapors, vapor density, physical constants of agents, and multiple targets

6) **In place and adequate sampling and detection plans:** Remote sensing devices, on-site detection devices, chain of custody of samples, public health laboratory capacities, and federal laboratory turn around capabilities.

7) **PPE:** Selection, availability, serviceability and interchangeability of personal protective equipment

8) **Training:** Psychological preparation, PPE training levels and PPE acclimatization of responders

9) **Command and Control:** Timely characterization of the crime/accident scene, size up, scene control, stages of response

10) **Site Security:** Timely mitigation, containment or disarmament of any secondary or tertiary CBRN device, evidence preservation, security of the scene, weapon/improvised device location, robotics.

All of these factors have one concept in common, TIME. Whether it is the time of agent employment, the time it takes to respond, the time available to rescue casualties, the time of use expected from the air cylinder of a SCBA, to the time of egress and recovery, time and the management of it, plays a critical role. Time management concepts that currently exist for CBRN SCBA consist of three time concepts. They are Service Life (Time), Rated Service Time, and CBRN Respirator Use life (Time).

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A. Service Life of CBRN SCBA and Components

Precedence exists for the NIOSH definition of 'Service Life'. Industrial respirator specialists know SCBA service life as the "period of time, as determined by NIOSH certification tests, in which adequate breathing gas is supplied." [DHHS (NIOSH) Pub No. 2005-100. 2004] This same definition loosely applies to the 42CFR84 use of the terms 'rated service time' or "service time". [42CFR84, Para 84.70, (a), (b), (2) (ii), Para 84.95, (a), (b), (c) and Para 84.53, (a), (b).1995]. For the purposes of CBRN SCBA, service life or time is still the same industrial definition with enhanced tactical use inference. This inference is situation dependent but may refer to the length of time the system as a whole or individual components (for example, facepiece, harness assembly, or regulators) are expected to remain functional based on time, exposure event, or number of uses. If the SCBA is exposed to vapor or liquid chemical warfare agents, the interim guidance related to CBRN Respirator Use Life (CRUL) applies.

The SCBA manufacturer may specify service life information for the system as a whole or for particular components in the manufacturer's UI; however industrial service life/time is commonly understood to be the 60, 45, 30 minute duration at specified pressure ranges. When specific service life information related to CBRN use or traditional industrial/fire use, is available from the manufacturer, it should be followed. To ensure all components are functional and free from damage and excess wear, an inspection of all SCBA components should be performed prior to the beginning of each shift or as the end user deems appropriate and certainly in accordance with the manufacturer UI. In making renewals and repairs, parts identical with those furnished by the manufacturer under the pertinent approval, shall be maintained.

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- Service Life of Air Cylinder

The service life of an air cylinder is the length of time the cylinder can remain functional before it must be removed from service and permanently retired. All manufacturers' guidance on cylinder service life is provided in the manufacturer's UI or available from the cylinder manufacturer. All information must be followed. The U.S. Department of Transportation (DOT) Title 49 specifies regulations for marking, hydrostatic testing at the time of manufacture, and re-qualification of cylinders at specific time intervals depending on the design type of the cylinder. Requalification of cylinders can only be legally performed at retest facilities which have been issued retest identification numbers by DOT. The re-qualification of cylinders requires a visual inspection, both internal and external, a hydrostatic test, marking or labeling and maintenance of proper records of the re-qualification. Re-qualification of SCBA cylinders is required with a frequency depending on the design type of cylinder. Generally, composite cylinders, those having a metal core wrapped in non-metal materials, such as Kevlar or fiberglass composites, are re-qualified every three years and all-metal cylinders are re-qualified every five years. The organization or cylinder owner and retest facility are required by DOT to know how often to have the re-qualification performed. DOT compliant carbon composite cylinders have a maximum service life, usually 15 years, as specified by the exemption issued to the cylinder. The service life of all-metal cylinders is determined at the time of re-qualification. If the cylinder passes the re-qualification, it can be used until the cylinder shows no external damage or until its next re-qualification.

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Before each use of the respirator, the hydrostatic test date on the cylinder should be checked to ensure that it is current. Cylinders which are past due for DOT re-qualification should be immediately removed from service until they are re-qualified or have reached the end of their service life.

Damage and wear of cylinder components will affect cylinder service life. The cylinder assembly (cylinder, gauge, and valve) should be inspected before each use to ensure that it is functional. The NFPA 1852 *Standard on Selection, Care and Maintenance of Open-Circuit Self-Contained Breathing Apparatus (SCBA)*, 2002 Edition contains recommended NFPA procedures for SCBA cylinder maintenance.

Cylinders should be examined for damage and wear before each use. Damaged cylinders must be immediately removed from service until adequately repaired. Signs of wear or damage which can affect service life are cylinder color change, burns, blistering, and deformities in the shape of the cylinder such as cracks, dents, weakened areas, and surface indications of penetrating chemical damage. Additionally, the manual rolling of cylinders on the floor to check for uniform cylindrical shape is a common practice in the fire fighter workplace [Email, Fire Department New York, 2004].

The criteria for conducting a visual inspection of the cylinders, including quantification of surface damage, are available, upon request, directly from the cylinder manufacturer or the SCBA manufacturer.

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The respirator manufacturer can provide specific guidance on reading and interpreting DOT markings on cylinders and how the hydrostatic test date markings are updated when a cylinder is re-qualified. Among DOT marking requirements which users should be familiar with are the following three items.

1) Hydrostatic Test Date

The hydrostatic test date is the date the cylinder was hydrostatically tested and considered qualified for use. DOT also specifies regulations for the periodic re-qualification of cylinders. The hydrostatic test dates appear on each cylinder in compliance with applicable DOT regulations. It is generally a month, a certification unique inspection symbol and a calendar year, i.e. 7th05, along with the issued RIN.

2) Cylinder Pressure Rating

Cylinder pressure rating is specified by the manufacturer to be either 4500 psig, 3000 psig or 2216 psig. The cylinder pressure rating on the cylinder must be checked against the manufacturer's UI and the SCBA in use, to ensure it is compatible with the SCBA system. Under certain OSHA provisions interchangeability between like pressure ratings but different SCBA manufacturer's air cylinders is possible on the incident scene. For further information concerning OSHA interchangeability of SCBA cylinders go to:

http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=23479

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3) DOT Exemption Number, Composite Cylinders/Specification Number, All-Metal

DOT exemption number or specification number corresponds to specific DOT regulations for cylinders, including retests and service life. All retesters, cylinder owners, and inspectors should be aware of any and all retest requirements and service life requirements pertaining to cylinders they handle.

- **Service Life of Facepiece**

All manufacturers' guidance on criteria for facepiece service life must be followed. The facepiece should be inspected before each use to ensure that it is functional.

Facepiece service life is affected by time, exposure event, operator maintenance, and number of uses. The elastomeric material of the facepiece must remain pliable to provide the best seal to the interface between the material and the pliable surfaces of the human face. Elastomeric materials of facepieces can become cracked, frayed, and lose elasticity over time. Cracks, tears, holes, or distortions of the facepiece may result from routine use or improper storage. Headstraps and head harness components should be replaced when broken, elasticity is lost or diminished, or excessively worn serrations on the head harness that permit slippage. Broken and malfunctioning buckles should be replaced. Facepieces with cracked or badly scratched lens should be removed from service repaired or disposed of.

Other components or accessories found on the facepiece which may need to be replaced or repaired are hydration devices, spectacle (glasses) inserts, heads-up-display systems,

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speech diaphragms, and communication devices which electronically amplify the speaker's voice or send electrical sound transmissions. Hydration devices, also known as drink tubes, are not NIOSH-approved for CBRN SCBA or traditional SCBA. Next generation CBRN SCBA may incorporate hydration, ESLI, protective suit interfaces and other assorted technology enhancements.

- **Service Life of Remaining SCBA Hardware**

Remaining SCBA components which must be inspected prior to each use are the backframe and harness assembly, hoses, End of Service Time Indicators (EOSTI), regulators, and system accessories. Damaged or mal-functioning hardware should be repaired or replaced by qualified personnel prior to use. The SCBA manufacturer may specify service life information for particular components in the manufacturer's UI. When this information is available from the manufacturer, it should be followed.

B. Rated Service Time Indicators: CBRN SCBA contain all the traditional NFPA compliant rated service time indicators and displays. The following three are the most prominent types.

- Heads-Up Display
- Pressure Gauges
- End of Service Time Indicators

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C. CRUL: NIOSH CBRN Respirator Use Life (CRUL) Cautions and Limitations Relating to Chemical Warfare Agent Exposure

NIOSH CBRN Caution and Limitation 'U' listed on the NIOSH approval label contained in the manufacturer's user instructions states:

U- "The respirator should not be used beyond 6-hours after initial exposure to chemical warfare agents to avoid possibility of agent permeation."

This statement means that following use in an environment which contains confirmed chemical warfare agents, in liquid or vapor form, the NIOSH-approved CBRN SCBA must be removed from service and disposed of following 6-continuous hours of use after the initial confirmed exposure. The SCBA should not be reused and should be decontaminated and disposed of in a manner that is consistent with the type of contamination and any local, manufacturer recommended or government regulations governing the decontamination and disposal of CBRN contaminated items.

Confirmed CWA contamination presence is the key to determining the 6-hour start point of contamination on a CBRN SCBA. Therefore, instruments designed to detect, at stated concentration levels, are required to be on the incident site. Once detection confirms the agent type and quantity present, the CBRN SCBA use life of 6-hours starts. The CRUL 6-hour time value means **6-continuous hours** in a single shift, day, or event. It does not mean 6-individual one-hour exposures in one shift or

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one day, nor does it mean 6-different one hour exposures over the course of 6-different days. 6-continuous hours stop at the 5-hour, 59-minute and 60-second mark.

Use beyond the 6-hour mark of continuous use in a confirmed chemical warfare agent (CWA) incident goes against the NIOSH Caution and Limitation "U". However, in actual use the incident commander at the scene of a CWA incident may be confronted with the decision to implement use beyond the 6-hour mark. For example, the need to rescue and recover victims, combined with a supply shortage of new CBRN SCBA units at the scene, could present such a need. Use of a contaminated CBRN SCBA beyond the 6-hour mark may put responders at risk to possible exposure of CBRN agent which could permeate the contaminated CBRN SCBA. The incident commander must determine that at the 6-hour mark, if the possibility of agent permeation has been negated by immediate and technical decontamination techniques.

Responders must also be aware of the possibility of indirect contamination by liquid or vapor CWAs which are also considered in the 6-hour use life rule. Indirect contamination may occur, for example, when CBRN SCBA are used in downwind areas from the response site or a liquid CWA contacts a unit through direct or indirect contact with other responders, victims, or equipment, outside of the target area. **The 6-hour use life rule should be obeyed even if the SCBA is contaminated indirectly.** However, the incident commander may determine, based on the type and concentration of CWA exposure and immediate technical decontamination techniques that modification to the 6-hour use life rule is possible.

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NIOSH CBRN caution and limitation 'T' listed on the NIOSH approval label contained in the manufacturer's user instructions states

T - "Direct contact with CBRN agents require proper handling of the SCBA after each use and between multiple entries during the same use. Decontamination and disposal procedures must be followed. If contaminated with liquid chemical warfare agents, dispose of the SCBA after decontamination."

In relation to the 6-hour use life, this limitation states that if contaminated by a liquid chemical warfare agent, the SCBA should be disposed of after decontamination. The limitation warns against reuse after a liquid exposure due to the persistency of some CWA liquids, for example HD is highly persistent as a liquid. In the case of a CWA liquid exposure, use beyond the 6-hour limit is highly cautioned against even when rapid technical decontamination can be performed. Decontamination should be performed in all cases for all confirmed CWA exposures, even if the CWA is considered non-persistent as a vapor, such as the case with GB. Even non-persistent CWAs vapors can permeate into and remain in materials, if exposure concentrations are high, such as in a confined space. CWAs are can also be airborne in the form of liquid aerosols which are small liquid particles and not in true vapor states.

NIOSH Interim Recommendations for Firefighters and Other First Responders for the Selection and Use of Protective Clothing and Respirators Against Biological Agents, DHHS (NIOSH) publication number 2002-109, states **decontamination of protective equipment and clothing is an important precaution to make sure that any particles or contamination that might have settled on the outside**

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of protective equipment are removed before taking off gear. Decontamination sequences currently used by hazardous materials teams should be used as appropriate for the level of protection employed. Equipment can be decontaminated using soap and water as part of a removal process, and 0.5% hypochlorite solution (one part household bleach to 10-parts clean water) can be used as appropriate or if gear has any visible CBRN contamination. Note that bleach may damage some types of equipment. After doffing all PPE, emergency response workers should shower using copious quantities of soap and water in a safe non-contaminated area.

D. Rationale for CBRN Respirator Use Life (CRUL) SCBA Cautions and Limitations

CBRN SCBA with confirmed chemical warfare agent contamination may not provide their intended full level of protection to users if used beyond the NIOSH 6-hour recommended use-life limitation. The rationale for the 6-hour use life limitation is developed from laboratory tests evaluating penetration and permeation resistance of complete dynamically operating CBRN SCBA systems to GB vapor and HD vapor and direct contact with HD liquid droplets. The 6-hours of testing require the SCBA to be refreshed with clean air essentially 5-times over the time of one test trial. This translates into the possibility that an air cylinder is replenished more than once in the use life of a CBRN response.

NIOSH testing utilizes a mechanical breathing pump attached to a zinc manikin head-form called a SMARTMAN (SiMulant Agent Resistant Test Manikin). The SMARTMAN headform has a respirator facepiece donned and tightened per the UI and remaining hardware is operational inside a

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confined space exposure chamber. The air cylinder is not present during this SCBA systems test, only the cylinder neck valve assembly, and a tooled adapter torqued to a pressurized air source line, is used.

For primary testing criteria, Acute Exposure Guideline Levels (AEGLs)- Level 2 one-hour level is used as the maximum breakthrough. But in addition, to verify that potentially high brief 'peaks' do not exceed levels of concern, peak concentrations identified in the test results are also evaluated against AEGL Level 2 10-minute levels, i.e., peak concentrations as measured in the test protocol, do not exceed the higher 10-minute level [Niemeier, Richard, 2001]. AEGL are established by a National Advisory Committee for the Environmental Protection Agency and the National Research Council. They represent threshold emergency exposure limits for the general population, including more susceptible portions of the population, and are applicable to emergency planning and decision making. The AEGL values are agreed upon through rigorous scientific discussion, consensus, and subsequent review in a transparent process by the public, other NIOSH scientists, DoD scientists and members of the National Academy of Sciences.

AEGLs address various degrees of severity of toxic effects that are represented by AEGL 1, 2 and 3. Each of these levels represents the lowest estimate of a concentration above which a specified effect might be observed in an exposed population. AEGL-Level 2 values are the most appropriate threshold exposure limits (breakthrough) values for GB and HD testing since they ensure no significant respiratory or long-lasting effects will result if approved systems are properly worn [Niemeier, Richard, 2001]. NIOSH NPPTL adopted these values in defining the performance standard for the CBRN SCBA.

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The duration of each test for each agent is 6-hours. NIOSH uses 6-hours because the most credible event was determined by a joint NIOSH/RDECOM analysis and is based, not on a worst case threat, but on a "most likely to occur" terrorist action concentration gradient. Toxicological analysis is used to define the required level of protection the SCBA must be capable of providing. The 6-hours consist of 30-minutes of actual agent exposure followed by 5.5 hours of natural decay. Due to the time-limit capacity of SCBA air cylinders being less than one hour, approximately 45 to 30 minutes depending on the physiology and work rate of the wearer, the overall one time exposure of personnel and SCBA equipment is expected to be less than one hour. However, responses at the Pentagon site in 2001 showed the same SCBA being used with the same or different cylinder for upwards of 12 hours per terrorism response shift [Arlington County After Action Report (AAR), July 2002]. SCBA were in short supply and responders going off shift did not want to surrender their SCBA to oncoming responders due to shortage of SCBA and possible concerns over communicable health issues. Air supply sources were in short supply and responders had to spend time looking for air replenishment sources while managing the cylinder air on site. The use of quick charge and other methods for cylinder air replenishment were used [Arlington County AAR, 2001]. These examples show how the same SCBA can be used for a longer duration than anticipated.

The NIOSH goal was to identify existing SCBA respirators that can ensure that overall physical and chemical safety is maximized. 6-hours achieved that initial goal. Only actual response(s) to a CBRN incident will determine if it is adequate.

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Both GB and HD are considered to be reasonable challenge agents given their extreme toxicity relative to industrial chemicals, their permeation and penetration characteristics, their relative ease to produce and their worldwide availability in thousands of metric tons. The test parameters for the HD test are the application of a maximum of 43, 20- μ l liquid droplets initially and then undisturbed for the entire 360-minute (6-hour) test duration followed by an HD agent vapor concentration of 300 mg/m³ generated during the initial 30-minutes of the 6-hour test. HD was selected because of its permeation characteristics. HD is a linear molecule that permeates surfaces overtime and interacts at the molecular level to stay bonded to the material. Ideally suited to contaminate terrain, equipment and cause delayed but prolonged affects on personnel, HD is considered to be a persistent classic chemical warfare agent by the US military.

The test parameters for the GB test are 2,000 mg/m³ of vapor/aerosol generated for the initial 30 minutes of the 6 hour test. GB was selected because it is the most volatile of the nerve agents, having a volatility of 22,000 mg/m³ and it has low molecular weight and molecular branched configuration (approximately 108 angstroms in length) enabling it to permeate through SCBA materials more readily than other G series or V series nerve agents. Scientific studies on dogs and rates indicate that exposures to 0.001mg GB/ m³ for up to 6 hour per day are unlikely to produce any signs of toxicity. Recent human test subjects exposed to nerve agents in the United Kingdom are just now surfacing in the international public media publications. GB is representative of the nerve agents; other nerve agents include GA (Tabun), GD (Soman) and VX. GB molecular configuration of approximately 108 Angstroms enables it to penetrate surface interfaces, seams, openings, crevices, overlaps, or dead spaces of SCBA materials. A liquid GB droplet test is not performed by NIOSH since GB is

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understood to be the most significant threat when aerosolized in aerial vapor dispersion rather than in a liquid droplet state. GB liquid evaporates at the similar rate of water and therefore presents a non-persistent, but highly toxic hazard that in a confined space requires both dermal and respiratory personal protection. Therefore, the GB vapor adsorbed on the surface of the SCBA is also a dual source of agent exposure from penetration or permeation challenge effects generated in the NIOSH NPPTL certification tests.

A combination liquid-vapor test is used for the HD tests, wherein liquid droplets of HD are placed on selected areas of the SCBA and a vapor challenge of HD is also introduced into the test chamber. The liquid droplets and vapor test the permeation resistance the respirator materials while indicating the integrity of the materials to withstand the persistent chemical effects of HD. Since the permeation effects of HD are essentially non-reversible, HD contamination remains at the molecular level and decontamination laboratory operations prove that high temperature water baths force HD out of material surfaces but do not force out all of the HD over a given period of reasonable water bath boiling exposures (4 hours to upwards of 72 hours or greater). Once a material exposed to a chemical warfare agent is decontaminated down to what is termed the 'XXX' level, it is acceptable for processing as a hazardous waste to the waste site collection point for incineration [RDECOM Protective Equipment Team IOP No. 12, March 2004].

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Figure 10, HD Droplet Pattern on Candidate CBRN SCBA. NIOSH LAT, 2003.

Chapter 5. CRUL Guidance Before, During and After Use

A. Section 1: Before Use Operations

i. Shipping

CBRN SCBA should be shipped in original manufacturer specified containers. Routine DOT hazardous material labeling for filled air cylinders is required. Special care should be given to ensure no excessive abuse of shipped containers occurs. Part numbers on original invoice should match CBRN SCBA part numbers of shipped order.

ii. Receiving

Upon receiving a new CBRN SCBA, thoroughly check that all components and accessories are included in the shipment, the user instructions are present, the NIOSH CBRN SCBA adhesive label is on the harness assembly and the NIOSH CBRN SCBA approval label paper insert is present in the UI. Match the individual component part numbers to the numbers listed in the respirator component column of the NIOSH approval label (paper).

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NFPA 1852 requires baseline posi-check of the SCBA upon receipt. A copy of the manufacturer's posi-check results should be provided with the SCBA. Ensure you know how to read it and forward any questions or noted errors to the respirator manufacturer.

iii. **Inspection, Maintenance and Storage of CBRN SCBA.**

This section provides guidance for the inspection, maintenance, and storage of CBRN SCBA. Users should **always** follow the manufacturer's suggested practices for inspection, maintenance, and storage of their individual CBRN SCBA model. A recommended reference is NFPA 1852 *Standard on Selection, Care, and Maintenance of Open-Circuit Self-Contained Breathing Apparatus (SCBA)*, 2002 Edition.

1) **Inspection**

General Criteria: It is critical that the user verify that all of the CBRN SCBA components listed on the NIOSH approval label (that is the matrix style paper insert) provided with the user instructions are present, correctly installed, and free from visible deterioration, wear, and damage. All guidance and recommendations made by the manufacturer should be followed.

Specific Criteria: The following inspection procedures should be performed before each use of the CBRN SCBA. Sequence is per the manufacturer's UI and the listing may not be all inclusive.

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Facepiece

- Check the elastomeric material for pliability, damage, tears, and cracks. Ensure no material defects are present
- Check that all head harness straps are fully extended, functional, elasticity is not lost, buckles properly function, and buckles or straps are not damaged. Ensure the types of head harness, Kevlar or butyl, and the visible part number for the head harness; match the CBRN SCBA label by part number and material, applicable to the NIOSH TC number for CBRN protection. If the part numbers do not match, contact the manufacturer. **If the part number listed on the matrix for CBRN configuration does not match the part number located on the actual part, DO NOT USE THE RESPIRATOR FOR A CBRN RESPONSE.** Ensure a CBRN part number is used because, if it is not, the same level of CBRN protection determined by the NIOSH CBRN approval will not be attained if a non-CBRN part number is used
- Check the lens for holes, cracks, scratches, heat-damaged areas, and a properly maintained locking ring and seal with the facepiece material
- Check the second stage regulator exhalation holes or valve for debris that, if present, would or could inhibit proper regulator seating/sealing and locking of the regulator to the facepiece assembly.
- Check the regulator connection(s) for damage and proper function.
- Check that the Heads-Up-Display, if present, is functioning properly.

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Backframe

- Check that harness straps and backframe are free from cuts, tears, abrasions, and indications of heat and chemical-related damage. Ensure the NIOSH CBRN label and harness assembly label are present and readable.
- Buckles and fasteners should be checked for proper adjustment. Fully extend the harness straps.
- The cylinder retention system should be checked for damage and proper operation and to ensure that the cylinder is securely attached to the backframe.

Cylinder Assembly (cylinder, gauge, and valve)

- Check that the hydrostatic test date on the cylinder is current. Cylinders which are past due for DOT re-qualification should be immediately removed from service until they are re-qualified.
- Check the cylinder body for cracks, dents, weakened areas, indications of heat damage, discoloration and indications of chemical damage.
- Check the cylinder valve outlet sealing surface and threads for damage, wear and clear any debris found.
- Check the valve hand wheel for damage, proper alignment, and secure attachment.
- Check the burst disc outlet area for debris. Ensure they are clear.
- Check that the cylinder is fully charged to the manufacturer's specified pressure rating. Air cylinders should be maintained in a fully charged state but should not exceed the manufacturer's maximum recommended pressure. Air cylinders should be recharged when the pressure falls below one quarter of the manufacturer's

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recommended full pressure level. Use the local department Standard Operations Procedure (SOP), respirator manufacturers UI, applicable NFPA codes and OSHA regulations.

- If the end user is technically qualified, he or she should ensure the neck cylinder valve assembly is fully serviceable and shows no bend in the neck valve or probe. Ensure the burst disc is clean and lubricated per the UI. Ensure the independent air pressure gauge internal to the neck cylinder valve is readable and showing proper air pressure when correctly torqued into the cylinder. If end user is not technically trained and qualified to conduct these checks, refer these actions to the next higher level of maintenance.
- DO NOT DROP the assembled CBRN SCBA on the high pressure hose coupling adjacent to the neck cylinder valve assembly.
- Dropping of the SCBA on other component parts may or may not produce adverse affects on the CBRN SCBA. All maintenance should only be done by a team or individual trained and certified by the CBRN SCBA manufacturer and in accordance with applicable standards such as NFPA 1404 code.

End-of-Service-Time Indicator (EOSTI)

- Check that all EOSTIs function and alarm in accordance with the manufacturer's instructions.
- The inspection should ensure that the alarms function properly by observing the alarm functions (visual, audible, or vibrating signals) over a period of time as specified in the user instructions.

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Regulator

- Check the regulator controls, where present, for proper function. Ensure all CBRN markings are readable and that unique CBRN components are in place per the UI.
- Listen for any unusual sounds such as whistling, chattering, clicking, or rattling during operation.
- Check that the regulator by-pass functions properly. Use the by-pass and check for correct de-pressurization/bled down.

Pressure Gauge

- Check that pressure gauges are functional and that the cylinder pressure gauge and the remote gauges read within 10% of each other. The remote pressure gauge can be a mechanical gauge face or a visual signal continuously displayed as part of a facepiece HUD.
- Ensure any vent holes are free of debris prior to activation.

PASS (Personal Alert Safety System) Device

- Check all operating modes for proper function in accordance with the manufacturer's UI.
- Ensure batteries are available and installed for operation per UI.

Final Pressure Check

- As the final inspection item, the entire CBRN SCBA should be checked for pressure retention. This is accomplished by closing all regulator valves, opening the

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cylinder valve thereby pressurizing the CBRN SCBA, and then closing the cylinder valve.

- The system should hold pressure in accordance with the manufacturer's specifications after the cylinder valve is closed. Ensure the length of time is stated in the UI. Reopen the valve and observe gauge changes for proper movement and stability.
- Following the pressure check, the system pressure should be released per the UI.

2) Maintenance

All maintenance, repairs, and replacement of parts on a CBRN SCBA are required to be done by trained and qualified personnel. Following any maintenance procedures, a qualified person should verify that the SCBA has been assembled to the correct NIOSH approved CBRN configuration, which is printed on the NIOSH CBRN SCBA approval label paper insert of the user's instructions. All maintenance is done in accordance with the manufacturer's user instructions, local departmental SOP and available conversations with the manufacturer's representative.

3) Storage

- Respirators required to be immediately available should be stored in a ready-to-use condition. This condition is normally manufacturer and departmental specific but overall, it is designed to protect respirators from excessive dust, excessive radiant

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sunlight, excessive heat transfer, incompatible damaging chemicals, or excessive cold and moisture, as specified in the UI.

- Facepieces and second stage regulators should be stored in normal use positions, if possible. Impaired functions of the facepiece or regulator may result if the facepiece elastomer is allowed to set in an abnormal position, such as inside a turnout gear jacket, wedged in between a seat and seat storage area, stored where the head harness straps are inadvertently over the facepiece lens/visor or the facepiece is exposed to the natural elements of weather for an excessive amount of time.
- Respirators not used on a daily basis should still be maintained for immediate use in the case of replacing a field deployed unit in accordance with end user standard operating procedures or supplemental. Some user instructions recommend storing facepiece in clear plastic bags after drying and keeping the dry facepieces bagged in storage cabinets. Contingency stocks/long duration un-used amounts of respirators stored in climate controlled facilities or designated logistic warehouses should be inspected regularly in accordance with CBRN SCBA manufacturer UI. It is recommended in CBRN SCBA, that are being used as dual-purpose SCBA, (dual-purpose meaning that they are worn for every day use and on order, CBRN response) be used for any additional training or maintenance prior to actual first time CBRN SCBA use.
- The OSHA Respiratory Protection Standard [29 CFR 1910.134] allows for SCBA to be stored in vehicle compartments or in specific SCBA covers/containers/bags on

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fire trucks/law enforcement vehicles/ambulances. Brackets that are mounted on a wall or to a stable surface (e.g. on a fire truck) are normally used to store SCBA. The brackets, when properly designed to a specific SCBA, ensure that the SCBA is secured, covered and not subject to being wedged in a constricted space that would likely produce facepiece distortion or air line hose compression.

iv. **Respirator Program Administrator or Incident Safety Officer Responsibilities.**

1. Differences between CBRN SCBA and Non-CBRN/Industrial SCBA are slight to significant, depending on particular SCBA. Respirator Protection Program administrators, incident safety officers, departmental health and safety officers or other similar type duty personnel have unique use challenges when integrating CBRN SCBA into an existing respirator protection program or when starting a new respirator protection program supporting known or new workplace health and safety requirements.
2. While the CBRN SCBA retains many of the same respirator program qualities of the standard non-CBRN SCBA, new "use" challenges such as implementing CBRN SCBA use life protocols, integrating CBRN SCBA decontamination operations, understanding CBRN SCBA Retrofit/Upgrade Kit instructions and requirements, recognition of CBRN SCBA administrative label markings, full department exchange of Non-CBRN/Industrial SCBA and cylinders for CBRN SCBA and spare cylinders and departmental initial and refresher training relevant to new aspects of departmental CBRN agent response, are likely.

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3. "Mask division" or "Mask Service Unit" personnel of a fire department are best suited to fully integrate manufacturer specific warnings, cautions, and alert messages pertaining to operation and maintenance of CBRN SCBA and Upgraded CBRN SCBA [Kreuger, November 2004]. Additionally, local emergency responders may have manufacturer trained and certified technicians that manage SCBA maintenance programs at the law enforcement, emergency medical or hazardous material response levels.
4. It is likely that in emergency responder departments replacing old SCBA with new CBRN SCBA, both Non-CBRN/Industrial NFPA compliant SCBA and CBRN SCBA will be present for a period of time. In that case and in incident response cases, responders should be thoroughly trained on how to differentiate CBRN SCBA from Non-CBRN SCBA. A few recommendations are as follows:
 - i. CBRN approved components can only be used in NIOSH-approved configurations shown in the assembly matrix on the inside page or pages of the specific CBRN SCBA user instructions.
 - ii. The NIOSH-approved CBRN SCBA can be used only with a specific type of facepiece model number, for example a Hycar material model number. Silicone facepieces, without butyl or

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Hycar skirts, are not NIOSH-approved for CBRN incident response.

- iii. The NIOSH-approved CBRN SCBA usually has specific types of 2d stage air-pressure regulator assemblies. These regulators are part number specific to specific NIOSH-approved CBRN SCBA. They should not be intermixed with non-CBRN/Industrial or non-CBRN/NFPA compliant SCBA.

v. **Training**

QUALIFIED INITIAL AND REFRESHER TRAINING ON ALL ASPECTS OF THE PROPER USE, EMERGENCY USE, USE LIFE and DISPOSAL of the CBRN SCBA, IS RECOMMENDED FOR ALL CBRN SCBA END-USERS.

To attain the proper respirator fit, seal and operational capability, end users should be trained, retrained and confident on how to use a CBRN SCBA before actual use. Users should know the UI thoroughly and practice donning, wearing and removing/doffing the CBRN SCBA to attain and maintain proficiency in a defined respirator protection program.

The information in this guide is intended to be administered through a complete respiratory protection program as described in OSHA, 29 CFR 1910.134. A complete respiratory protection program covers criteria for selecting respirators, medical evaluations, fit testing, maintenance, inspection, cleaning, storage, worker training, and regular effectiveness evaluations of the program. The respiratory protection program is to be

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directed by a designated knowledgeable professional, commonly known as the respirator program officer/administrator (RPO). Incident safety officers (ISO) and health and safety officers (HSO) play key roles in convincing responders that responder safety is a priority on the worksite and that safety awareness and actions can minimize acute and potentially chronic workplace exposures. The respirator program administrator interacts with management and oversees all aspects of the respirator program. The RPO and the ISO/HSO should be available to the user for questions or concerns on respirator use.

The required training under the OSHA Respiratory Protection Standard [29 CFR 1910.134] includes:

- Why the respirator is necessary and how improper fit, usage, or maintenance can compromise the protection of the respirator
- What the limitations and capabilities of the respirator are
- How to use the respirator effectively in emergency situations, including situations in which the respirator malfunctions
- How to inspect, put on and remove, use, and check the face seal of the respirator
- How to recognize medical signs and symptoms that may limit or prevent the effective use of respirators

Information relating to the OSHA Respiratory Protection Standard [29 CFR 1910.134] is available at the OSHA Respiratory Protection website at:

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<http://www.osha.gov/SLTC/etools/respiratory/index.html>

vi. **Air Sources**

1. Compressed air supply sources for CBRN SCBA are identical to Non-CBRN/Industrial SCBA air sources. The quality of air in an air source requires regular inspection.
2. CBRN SCBA requires the same "grade of air" routinely used in fire fighting, law enforcement or industrial/non-CBRN SCBA workplace environments.
3. Select CBRN SCBA certification test trials show non-toxic particulates circulating in the air pressure boundary of the tested SCBA. In the course of NIOSH CBRN SCBA certification testing, certain CBRN SCBA have been identified as producing particulates in the exhalation air flow of the operating SCBA. These non-toxic particulates are thought to be oil, water and other compounds off-gassing from the internal mechanisms of the SCBA. These particulates have been detected by NIOSH in the live agent testing portion of the NIOSH CBRN SCBA certification program. Manufacturers that have high particulate counts are required to provide Material Safety Data Sheets (MSDS) stating what the health impacts are from the off-gassing particulates, prior to receiving a NIOSH-approved CBRN SCBA administrative letter.

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4. Before use in a CBRN incident response, air sources should be fully compliant with all Compressed Gas Association (CGA) requirements for Grade D air, at the minimum.
5. CBRN contamination of air sources during an incident response or attack is best prevented by locating the air sources away from contamination or shielding them in suitable containers/areas. If air sources become contaminated, quantify the contamination to ensure the air source is contaminated, tag the source and locate/procure uncontaminated air sources for immediate or future operations.

NOTE: DO NOT USE AN AIR CYLINDER THAT CONTAINS, OR IS SUSPECT OF CONTAINING, CONTAMINATED AIR.

6. Compressed 'gas'/air cylinders used with CBRN SCBA are DOT certified and exempted. And for this reason, the solitary cylinder with out its neck cylinder valve assembly is required to be tested in NIOSH CBRN SCBA certification trials. Only the cylinder neck valve assembly of the cylinder or cylinder family is tested. The cylinder neck valve is adapted to a high pressure or low pressure air line by threading the cylinder valve into a specific NIOSH tooled adaptor. The adapted assembly is then correctly tighten to the appropriate torque value for that particular pressure range, per the manufacturer's UI and supplements. The adapted cylinder neck valve interfaces with the incoming high or low pressure air

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line and allows the CBRN SCBA to be tested continuously during the 6-hours of certification testing, while using a continuous quality air source.

vii. **CBRN Incident Detection Methodologies Used in Before Operations**

1. Emergency responders may train on three types of CBRN incident detection methodologies before actually responding to a CBRN incident. The three types are as follows: training on the types of CBRN qualitative indicators, training on qualitative detection actions/kits and training on sampling and monitoring actions required for formal chain of custody quantitative detection methods.
2. Knowing before an incident response that there are certain chemical agent qualitative indicators involved in a response call, should increase responder size-up efficiency and add a level of safety awareness that will allow responders and response agencies to respond in a more cohesive manner.
3. Examples of chemical agent qualitative indicators are as follows: standing pools of unknown liquid on flora/fauna/manmade surfaces with no odor thresholds or mild odor thresholds/off-gassing, visible colored or gray colored aerosol clouds slowly moving or stagnate in low lying areas, or overt visible indicators such as humans or animals in respiratory distress, prostrate humans or animals, or immobile humans or animals with excessive salivation, bodily excrement or convulsions.
4. Examples of chemical agent mild odor threshold smells are as follows: new-mown hay/cut lawn grass, green corn, faintly or overtly fruity smell, camphor,

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peach kernels, musty, damp dirt or basement smell, sugary sweet, shellac/varnish, bitter almonds, pungent acid like, mild to severe garlic, horseradish, soap, slightly geranium smell, alcohol and ammonia mixture, or strong to light fish odor.

Knowledge of odor threshold types, not normally encountered on routine area calls, may assist emergency responders in assessing a chemical agent incident in progress or in completion. The above examples are not all inclusive.

5. The before operation action of preparing CBRN detection instrumentation at the departmental level requires proper maintenance, continual training and correct utilization of all available CBRN agent detection methodologies and instrumentation in the department and mutual aid agencies.
6. Detection monitoring training and refresher training done before CBRN operations commence should allow a higher level of mission accomplishment during actual CBRN response. The actual detection of CBRN agents is likely the most difficult aspect of a CBRN incident response.
7. Currently, CBRN agents are not easily detected with monitoring technology available to emergency responders. Most direct reading monitors or hand held detectors/detection equipment have limited sensitivity and selectivity when it is necessary to give a "yes" or "no" to agent presence. The monitoring Limits of Detection (LOD) for the most common hand held fielded instruments are typically higher than the expected CBRN exposure levels capable of causing harm to exposed emergency responders. Additionally, the lack of agent selectivity or the potential for response to interferences from fake or "non-true" agents, may

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prevent first responders and first receivers from making a determination that a potential CBRN agent is

- i. present/**positive**,
- ii. not present/**negative**,
- iii. not present but detector tells it is
- iv. or may be present/**false positive** or present but detector tells it is not/**false negative**.

The clear identity of that agent or agents is best determined by more specific monitoring technology, like that typically found in laboratory based instrumentation at the county, state or federal public health or scientific research laboratories levels [Kennedy, Eugene: November, 2004].

8. The action of CBRN Agent Detection is the lynchpin of emergency responder safe operations under CBRN conditions. Available qualitative and quantitative detection instruments can be maintained and at the ready to assist in assessing gross CBRN agent presence at the response site. These instruments will also provide an indication of the presence of CBRN agents on personal protective equipment, to include CBRN SCBA. However, the results from these instruments should not be used to determine "all clear" areas, determine the absence of contamination on equipment or personnel or quantify the type of contamination present. Detection accuracy is paramount and therefore, sample collection operations should use highly reliable laboratory methods and a documented chain

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of custody. The health of responders and the potential discarding or saving of responder equipment will rely on the quality of laboratory methodologies used to determine the existence and identity of a CBRN agent. Examples of direct read instruments and kits available today are the common military products such as the M256A1 Kit, M-8 Paper, M-9 Tape, the Chemical Agent Monitor (CAM), the Improved Chemical Agent Monitor (ICAM), the ICAD Miniature Chemical Agent Detector, ABC-M18A2 Chemical Agent Detector Kit, the M272 Chemical Agent Water Testing Kit, and the APD-2000 CW Agent Detector (this list is not all inclusive) and rapidly changing civilian products such as developments in wireless gas detection, Surface Acoustic Wave (SAW) -based CWA and TIC detectors, RAZOR™, field hardened, biological agent detectors and Multi-Ion Mobility Spectrometer (Multi-IMS) CWA and TIC detectors. These hand held direct reading instruments may contribute to assessing the local contamination presence and help establish zones of protection (Hot Zone/Red Zone, Warm Zone/Yellow Zone or Cold Zone/Green Zone), however, the instruments are subject to interferents and inadequate lower levels of limits of detection. A laboratory qualified to make chemical agent identification should be used to determine the type and quality of CBRN agent present.

9. Initial detection/monitoring qualitative and quantitative results are important in providing risk assessment criteria to the incident commander in determining the start time of use life for a CBRN SCBA and other relevant PPE.

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10. Pre-maintenance checks and operations are necessary before "use operations" start to ensure all available detection instruments are operational within manufacturer specifications and the instruments are pre-positioned to support ease of use.
11. The necessity to confirm, by means of either qualitatively or quantitatively monitoring, the presence of chemical warfare agents is critical because without some form of detection, the incident commander must assume the "worst case" and consider all CBRN SCBA as contaminated from initial onset of incident response to a CBRN event. The practice may result in numerous CBRN SCBA respirators being discarded at the end of the first 6-hour period, if detection measures are not fully qualified and implemented in support of hazard zone analysis, respirator selection and respirator use logic. Default timing concepts may be used if detection is not possible and may involve quarantine of suspected CBRN SCBA until monitoring results are available.
12. NIOSH CBRN SCBA use life limitation of one total 6-hour period following the initial confirmed exposure to a chemical warfare agent is highly variable if detection instruments are not used to identify that something is, at best, determined present.

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viii. **Decontamination Preparation of CBRN SCBA**

1. In order to conduct decontamination operations in a CBRN incident response, proper training, decontamination methods and decontamination equipment should be procured in the before use operational phase. Individual emergency responders will benefit from the use of immediate decontamination processes that help in removing gross CBRN contamination from PPE and other surfaces. A decontamination plan should be in place and appropriate skill level decontamination training should be part of a CBRN emergency response plan.
2. Currently, gross decontamination with plain water is the most common decontamination process in use by fire department emergency responders.
3. The use of disposable protective ensemble suits, that encapsulate the responder and the CBRN SCBA, may prevent contamination of the SCBA and the responder and thus limit the amount of decontamination and disposal operations. This standard protective measure was effective in recent anthrax responses whereby the disposable ensemble was discarded while retaining the SCBA.
4. Decontamination methods should be employed that address the particular CBRN agent type, **if known**. Decontamination processes, based on EPA adjusted bleach pH methods, have been demonstrated by the EPA as capable of providing upwards of 6 logs of kill effect for biological agents, after sufficient residence

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time on porous or hard surfaces. This means that with the proper use of pH control measures exponential logs of kill can be achieved by maintaining proper pH ranges of the decontamination solution. Methodologies for decontamination of select chemical warfare agents, biological agents or toxic industrial compounds are formulated by the EPA. [EPA, April 2005]

NOTE: Various bleach solutions may deteriorate or etch some SCBA harness materials and may not be detectable by the wearer at the time of deterioration. [MSA, 2004].

For additional information regarding the adjusted bleach pH method of decontamination see the following links:

<http://www.fema.gov/txt/areyouready/areyouready.txt>

<http://ehp.niehs.nih.gov/members/1999/107p933-974munro/munro-3.html>

<http://www.epa.gov/etv/verification/testqa-index.html#bdt>

5. Depending on suitability and availability of individual decontamination kits for emergency responders, CBRN SCBA may benefit from emergency responders having local individual decontamination kits such as the M258A1 or M291 kits available to remove gross CBRN contamination at the time of exposure.
6. Caustic solutions of decontaminates, while routinely available, will deteriorate CBRN SCBA and other PPE.

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7. Decontaminated CBRN SCBA, based on field measurements, should be isolated and held until the contamination is confirmed by qualified laboratory tests.

ix. **Electronic Communications**

1. CBRN SCBA are approved with specific communications accessories and before use operations should ensure communications platforms and accessories are mounted correctly and do not impede form, fit or function of the CBRN SCBA.
2. Before operations actions for communications products on CBRN SCBA should be conducted in accordance with local fire ground SOP, SOG or All Unit Circulars (A.U.C.)

x. **Extreme Weather Conditions**

1. CBRN SCBA being prepared for before operations in possible extreme weather conditions should be maintained per the manufacturer user instructions. Usually, SCBA user instructions contain the minimum use temperatures for operating the SCBA. If the UI does not state this, contact the manufacturer. Application of anti-fog coatings to the interior of the lens may be required prior to use in a cold temperature environment.
2. Extreme weather conditions, such as freezing temperatures, are not ideal conditions for CBRN agent employment. HD turns solid at temperatures equal to or lower than 14.45 °C /54.5 °F [Department of Defense, January 2005]. However, as the temperature increases, it is generally understood that the HD contamination that is present will recreate permeation and penetration hazards as it melts.

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3. Confined spaces may present high ambient temperature conditions and CBRN SCBA is designed to withstand appropriate high temperature exposures per NFPA 1981 compliance testing. Users should refer to NFPA 1981 or the appropriate user instructions for temperature use ranges. All NIOSH CBRN SCBA have been tested at a relative humidity of 50 +/- 5% and a temperature range of 25 +/- 3 degrees C.

xi. **Mixing of Non-CBRN/Industrial, Non-CBRN/NFPA and CBRN Parts**

End users focused on management response realize that before response operations such as equipment preparation, equipment load planning, and equipment re-supply contribute to the extent of mission success. If parts of CBRN SCBA are inadvertently mixed with any type of Non-CBRN SCBA parts, NIOSH approval is void and death or severe injury could result from use of what is becoming known as a "Mismatched SCBA". The CBRN SCBA approval is only maintained when the parts and accessories listed on the official NIOSH approval matrix maintained by NIOSH and the official NIOSH SCBA label issued with the manufacturer's user instructions are used. Crisis decision-making, for firefighters and emergency medical personnel primarily focused on saving lives, requires careful assessment of compatible NIOSH CBRN SCBA and industrial SCBA.

Mismatch of those two different types of SCBA will void the NIOSH approvals of both and may result in death or serious injury to the wearer. Non-CBRN parts cannot be substituted

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for CBRN parts. Further, a CBRN SCBA with substituted Non-CBRN parts is not expected to provide the same level of protection as a correctly assembled CBRN SCBA using the specified parts in the approval matrix. Select manufacturers have color coded critical parts of a CBRN SCBA in an effort to prevent mismatching and for ease in identification and reassembly.

xii. **Interchangeable Compressed Air Cylinders for CBRN SCBA**

1. NIOSH-approved CBRN SCBA is required to use specified compressed air cylinders/bottles as listed on the approval label.
2. Variations between NIOSH-approved CBRN cylinder neck valve assemblies and Non-CBRN cylinder neck valve assemblies may exist for field deployed SCBA, however, with the advent of NIOSH CBRN SCBA marketing, those variations are slowly being changed due to the fact that most new cylinder neck valve assemblies are CBRN approved and manufacturers have chosen to make the CBRN neck cylinder part number standard on either an industrial SCBA or a CBRN SCBA [NFPA 1981 TG Interchangeability, 2005].
3. Crisis response may force an incident commander to use different CBRN SCBA air cylinders/bottles on compatible air pressure range hardware. "Like" air pressure duration cylinders from different manufacturers are not recommended for interchange between NIOSH CBRN SCBA. Their use will void the NIOSH CBRN approval and may cause a safety hazard especially in the case of a field

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deployed, Non-CBRN approved cylinder, fitted to a CBRN approved hardware system.

4. The use of any prototype universal cylinders, such as a NFPA Universal Cylinder and Valve Assembly, is not NIOSH-approved and will void the NIOSH-approved CBRN SCBA.

B. Section 2: During Operations

1. Donning.

1. CBRN SCBA are expected to be put on or donned in clean or CBRN contamination-free environments. CBRN contamination is itself unpredictable due to many variables. If as a CBRN SCBA user, you are caught off-guard by a secondary or primary CBRN device explosion, spray or other source of contamination, close your eyes, hold your breath and don the CBRN SCBA facepiece and regulator as fast as possible. Do a user's seal check while still holding your eyes closed in case you have inadvertently trapped agent while donning the facepiece. Use of the red bypass valve to clear the respirator is also an option but contingent upon how much air is available. Placing the SCBA on your back should only be a priority after you have successfully donned and activated the CBRN SCBA. Use of the reduced profile maneuver in reverse may allow enough time to protect the respiratory system from exposure. Resume normal SCBA wear posture once the situation is stable, or if the requirement to evacuate the area is specified. A second person may need to provide the

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required assistance to effectively don the SCBA when the facepiece is donned and activated separately, before placing the SCBA on the back.

NOTE: Each individually manufactured CBRN SCBA may have unique donning measures required to be performed before or during donning. Do not use a partially full cylinder for CBRN SCBA response. If the cylinder is not full, the service time is reduced accordingly. The use of cover lens on CBRN SCBA facepieces/visors may provide an additional layer of protection to the facepiece or may catastrophically fail when exposed to HD, in particular, if not NIOSH-approved for CBRN. Hiss or pop sounds from the SCBA during donning/activation warrant non-use of that SCBA. Pressure gauge readings should correspond correctly when all air leak checks are conducted. Any regulator seating rings not seated properly in grooves should be re-aligned properly. The planned use of an integrated PASS panic button could provide a standardized warning measure to fellow responders that a CBRN event has occurred on the site. Ensure you consult with the respirator manufacturer service repair if any obvious or delayed performance indicators are not to manufacturer specification before responding to an incident. If the SCBA malfunctions during use, notify IC, seek air re-supply and initiate egress actions as soon as practical.

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Recommend strict attention to the before use training conducted on the CBRN SCBA and regular reading of every page of the UI on a regular basis for new rookie responders to ensure unique donning practices such as turning an 'AIR KLIC' device counterclockwise to tighten it or ensuring a slide is debris free, are in fact, done prior to donning the SCBA.

2. **Use.** Actual use actions, after successful donning of the CBRN SCBA, are dictated by the type of incident response (CBRN, CBRNE, B-NICE, Explosive, TIC etc.). If during use, the CBRN SCBA face seal is broken, every effort should be made to escape the hazardous area. While escaping, attempt to regain the facepiece seal by performing the manufacturer's facemask user seal/fit checks or other appropriate methods such as "purge-on" etc. In CBRN contaminated environments, over pressure, also known as positive pressure, from the pressure-demand SCBA, may provide a level of protection, but CBRN certification tests have shown that a uniform, firm, face-to-facepiece seal is one of the measures to protect the breathing zone, during inhalation and exhalation. Static pressure, which is the pressure in the facepiece at 0 psig flow, can range between 0.0 to 1.5 inches of water pressure. A NIOSH-approved SCBA is designed to maintain positive pressure in the facepiece during the NIOSH breathing machine test at a ventilation rate of 40 liters per minute or 115 liters per minute peak flow. During the inhalation cycle of a breathing machine, the facepiece pressure can vary from 1.5 to 0.0 inches of water column pressure. Static air pressure in the breathing zone of a NIOSH-approved SCBA is less than 1 psig. It has an exact range of 0.0542 psig to 0.1265 psig or 1.5 inches to 3.5 inches of water pressure [NIOSH, 2001].

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Wearing SCBA may have different meanings to different types or levels of responders. It may mean having the SCBA harness on your back, with the facepiece in a standby hanging position on an equipment hook, or fully wearing the entire respirator, per the applicable user instructions.

Using the SCBA may mean having the facepiece donned and on air while the SCBA hardware is on one's back or in the reduced profile maneuver position.

Current day examples of when SCBA are actually used have been discussed in numerous publications. However, actual specific use requirements for SCBA wear/use are normally directed by local departmental regulations. Literature search shows that generally, all emergency responders use SCBA when performing the following typical response actions:

- a. interior structural firefighting operations to save lives
- b. interior structural firefighting operations when toxic substances or smoke are present and all civilian personnel are evacuated
- c. operating at outside positions while being exposed to smoke or toxic substances downwind or upon entry
- d. operating in confined spaces as defined in training bulletins or other standard operating guidelines
- e. other than structural operations emergencies as necessary etc

Removal of CBRN SCBA under those conditions, when used, is also regulated by local regulations, but generally, responders operating in smoke or toxic

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atmospheres, CBRN included, should not remove CBRN SCBA facepiece

except

- 1) When in a clean area
- 2) The cylinder is depleted and in a clean area,
- 3) The SCBA is malfunctioning so as to terminate air supply and enough respirable air is available to allow egress
- 4) The downed firefighter SCBA is empty and Rapid Intervention Team (RIT) responses in a life saving support mode, with no risk to agent exposure.

The emergency responder must be aware that the risk of removing the facepiece in a CBRN environment may result in exposing themselves or the intended to be rescued responder, to a minimal, significant, or fatal exposure. CBRN agents are more lethal, toxic, potent and faster acting than other toxic hazards normally encountered on the fire scene or crime scene.

The sharing of CBRN SCBA between emergency responders is not recommended, whether it is the same facepiece that is being shared or the same entire SCBA or separate hardware. Rapid Intervention Team (RIT) response may require the sharing of respirators to allow escape. If used, the practice of going on and off air, as the situation allows, in CBRN contamination, is very likely to cause minor, to major CBRN agent exposure, resulting in acute or chronic health conditions or death.

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The use of "bite bars" or other devices designed to modify the air pressure boundary of a CBRN SCBA are not recommended. Emergency responders are cautioned against jeopardizing their health by non-compliance with NIOSH CBRN SCBA approval requirements, non-use of appropriate NIOSH CBRN approved respirators or by the possible use or mis-use of non-manufacturer specific modifications or adapters while using the CBRN SCBA.

2. CRUL as It Relates to End of Service Time Indicators (EOSTI).

CBRN SCBA have standard NFPA and NIOSH EOSTI. Use of them is highly recommended to ensure proper escape/egress time is pre-planned and executed. Any local changes to the manufacturer's set EOSTI are the responsibility of the manufacturer and, if required, the organization/department/agency that purchased the SCBA. Significant design modifications to previous approved EOSTI engineering designs require NIOSH approval.

CBRN SCBA cylinders and components have expected service life and service time and when contaminated, expected use life (CRUL = 6). Indicators relevant to both service life and use life should be observed. An improvised CBRN agent contamination use life "indicator" program may use default timing procedures that rely on a stoppage of use at the 3- to 5-hour CRUL mark, if on the job workplace detection methods are not present, are present, but not rapid enough, or unreliable. This does not change the CRUL time value of 6-hours, but provides a safety factor to allow the responder to egress. Processing of contaminated SCBA at that time, may involve SCBA equipment quarantine until environmental sample results from the response scene are available one, two, or three-days

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later. Most likely, if sample results do not confirm type of contamination within one day, contaminated CBRN SCBA in the default timing pattern should be considered for discard due to potentiality for CBRN, specifically chemical agent, permeation.

Field-deployed SCBA upgraded to CBRN SCBA protection used for 6-hours in a CBRN chemical agent contamination response cannot have select retrofitted parts changed out and replaced and the CBRN SCBA made serviceable for use. Chemical agents do not distinguish between old or new parts, just the readiness of the material to penetration or permeation effects.

vi. **Use and Cautions and Limitations Statements.**

NIOSH cautions and limitations (C&L) are lettered and cover a spectrum of industrial and CBRN respirator approvals. They are understood to be assigned by NIOSH in alphabetical order and certain letters may appear to be missing in certain NIOSH respirator specific publications. They are missing because they are not applicable to the class of respirator or type of protection being addressed. For example, CBRN SCBA C&L are lettered I, J, M, N, O, S and then Q, R, T and U. The missing cautions and limitations letters of "P", "V" etc...are not present because they are not assigned to that class of respirator.

vii. **CRUL/Use Related to RIT or RIC/UAC.**

Rapid Insertion Team (RIT) operations for emergency responders wearing CBRN SCBA are becoming more common place. RIT use universal air connection adapters and lines to mate up with downed responders and provide that downed responder life saving

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respirable air. While the integration of a Universal Rapid air Connection/Universal Air Connection (URC/UAC) assembly or any extension air system accessory is recognized on a NIOSH-approved CBRN SCBA, NIOSH does not approve CBRN "protection" for the actual use or a RIC/UAC/URC/Extension air system accessory female connectors or air sources in a CBRN environment. NIOSH approves only the integral RIC/UAC male connector located on the approved CBRN SCBA hardware and not the actual connection of the RIC/UAC to a compatible interface in a CBRN environment.

viii. **Use Related to Quick-Fill ® /Quick Charge.**

Use of authorized accessory assembly air hose lines integrated with NIOSH CBRN SCBA approved hardware to quickly fill depleting air cylinders under potential or actual CBRN contaminated environments is not approved by NIOSH. However, NIOSH CBRN SCBA do have approved air line hose assemblies integrated per manufacturer applications and these devices are safe while integrated to the CBRN SCBA but only the male connectors are NIOSH CBRN approved and the female quick fill connectors are not.

If quick charge/quick fill operations are done, the quick charge of back packed mounted compressed breathable gas cylinder replenishment should be done in a clean, protected, and 'CBRN contaminated free' areas. And if done in a contaminated area, the cylinder replenishment should be upwind of the contamination and done as quickly as possible and only for life saving measures as directed by the incident commander or existing OSHA waivers in effect.

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Rest cycles for responding personnel should be implemented. The most likely time for a responder to rest is when the air cylinder is being exchanged for a full cylinder [Kreuger, Michael, November 2004].

ix. **Use Related to the Red By-Pass Valve.**

A red colored by-pass valve is required to be present on all NIOSH CBRN SCBA. If a CBRN SCBA second stage regulator fails in the closed position, the red by-pass valve is used to provide forced compressed air into the second stage regulator area and the breathing zone/nose cup while bypassing the second stage regulator first breath activated mechanisms. The actual turning of the bypass valve to purge the air line has not been done under NIOSH CBRN SCBA certification test procedures. However, NIOSH has demonstrated that the purge valve does maintain a safe air pressure boundary while un-engaged in CWA LAT because of the simple deduction that the bypass valve did not fail or contribute to failing properties of the tested CBRN SCBA. Since the air pressure boundary at the purge valve does not allow GB, HD or corn oil penetration or permeation while the boundaries are pressurized, it is deduced that activating the purge valve will not have an adverse effect on the wearer while CBRN agent conditions are present. However, further research and testing is warranted in this area to determine the effects generated by turning the bypass valve on in a CBRN contaminated environment.

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NOTE: Operating the By-Pass Valve, also commonly known as the Purge Valve, should only be used for escape purposes. Emergency responders wearing CBRN SCBA should exit the scene in accordance with local requirements, when any type of malfunction is detected on the CBRN SCBA. Using the red by-pass valve, to by pass the second stage regulator will expend air at a faster rate from the compressed air cylinder of the SCBA and provide an immediate flow of rapid breathable air into the breathing zone of the user. Emergency responders that have subdued red purge valves must be thoroughly trained in advance to know and use the purge valve as an escape method under CBRN contaminated or CBRN exposure conditions.

x. **Preparation for Escape.**

Use of the By Pass Valve/Purge Valve or normal second stage regulator is recommended for preparing to escape from CBRN contamination. In the situations where gear bags or other equipment are brought into a CBRN contaminated area, responders should exercise caution as it relates to contamination transfer from those items during the egress. The use of gear bags or extra vital equipment used in a CBRN response may serve to spread contamination or carry it to other exclusion zones of the site, unknowingly. Detection methods serve as vital measures to ensure that CBRN contamination is not spread, mitigated and contained within workable exclusion zones.

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xi. CBRN SCBA Failure.

If CBRN contaminants are suspected or known to be inside your facepiece, close your eyes, hold your breath, use the By- Pass Valve to purge/flush suspected contaminants out as fast as possible, reseal the facepiece and grossly decontaminate known agent locations on the equipment and yourself, and then, or simultaneously, immediately escape out of the contamination.

CBRN SCBA are not expected to fail provided proper training is received, SCBA is fully serviceable and the respirator is worn, and used correctly. CBRN SCBA failure indicators may be rapid or slow. Penetration or permeation of CWA, TIC or biological contaminants into the breathing zone will likely be the first indicator the CBRN SCBA has failed or is starting to fail. Second indicator may be grazing or seam cracking of select SCBA material surfaces, especially those under pneumatic pressure or manual tightening. When this occurs and if it is noticed, acknowledge it and make a risk assessment based on amount of air left, mission requirements and expected egress time to complete the mission.

In a catastrophic failure of a worn CBRN SCBA such as a neck cylinder valve breach, crack or catastrophic discharge due to a compromised cylinder, if the emergency responder does not do a quick release of the SCBA, the responder will experience severe injury or death due to the sudden expenditure of pressurized air. If the SCBA harness assembly can be taken off while it is discharging, the responder will likely sustain fewer injuries than if the responder kept it on and tried to manually control the discharge with brute physical force.

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If possible, the By-Pass valve “purge-on” action is recommended for escape purposes when the breach is noticed and as soon as any sign of SCBA failure is detected. Use of the By-Pass valve will deplete cylinder air pressure faster than second stage regulator operations.

The responder two-man rule is even more critical in CBRN responses. Much like routine fire responses, the use of buddy teams/two-man rule (OSHA 2 in 2-2 out) should assist in detecting pre-failure indicators. For long duration decontamination processes, supplied air line respirators (SAR) with compressed air cylinder escape bottles, are possible for use, provided the air lines are kept clean of contamination. As of 2005, NIOSH has not approved SAR with CBRN protection nor has NIOSH started concept development of a law enforcement specific CBRN SCBA standard.

xii. **CBRN SCBA Accessory Failure.**

CBRN SCBA accessory failures, due to malfunction or CBRN caustic effects, will cause that accessory to be discarded or rendered un-usable. If only a specific accessory such as the integral PASS device is splashed with liquid CBRN agent, the remaining SCBA hardware may not be contaminated. Monitoring of the SCBA with litmus paper sampling (known as “papering”) or hand held calibrated point detectors may assist in determining the range of contamination splatter on a CBRN SCBA. Knowing where contamination is exactly at on the equipment assists in more rapid surface decontamination by helping to identify the areas that need specific decontamination over the areas that are not contaminated. Gross decontamination should nevertheless, still be done with the

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understanding that contaminated run off should be prevented from contaminating the rest of the supposedly clean SCBA and surrounding area. Contamination avoidance through the use of fine spray nozzles or localized washing of suspected components of the CBRN SCBA that are contaminated, may reduce amounts of contamination from spreading, penetrating or permeating equipment surfaces.

xiii. **Withdraw.**

Only clean, non-contaminated CBRN SCBA should be withdrawn from the incident site, in accordance with the relevant local departmental protocol. CBRN SCBA contaminated with chemical warfare agents should not be withdrawn for any reason, especially future use, from an incident site. Contaminated CBRN SCBA should be handled appropriately through a defined contaminated equipment route for proper decontamination, accountability and eventual disposal.

xiv. **Escape.**

CBRN SCBA do not provide integral escape bottles or other means of providing escape air, except through use of the by-pass/purge valve. Use of RIT to provide replenishment air is per incident commander authority and most likely will only be used to save a life and not to extend work times in a CBRN environment.

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Section 3: After Operations

i. Unmasking Procedures.

Unmasking procedures or removal of the facepiece while on air should only be done after the ambient air has been characterized to be below the determined safe exposure limits for a particular CBRN agent or agents. NIOSH CBRN SCBA should not be removed, for any reason, while wearer is still in a CBRN contaminated environment. Before unmasking procedures are conducted, ensure local decontamination of equipment has been performed. An appropriate decontamination procedure should be selected based on the type of contamination involved or expected, known effectiveness of the procedure, estimated or known procedure dollar cost, availability of decontamination materials, and ease of decontamination process implementation. The use of qualitative detection technologies, coupled with voluntary unmasking procedures (Unmasking Procedures with or without the M256A1 kit) is not recommended in an actual or suspected hot zone or warm zone of a CBRN incident.

ii. Doffing.

Doffing/removing taking the CBRN SCBA off is a deliberate process outlined in appropriate SCBA user instructions. In the case where CBRN contamination is known to exist, removing the CBRN SCBA should only be done under strict contamination control measures and decontamination procedures. If the CBRN SCBA is clean, doffing should be done in a safe area.

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iii. **Handling of CBRN SCBA.**

Handling is defined as to touch, lift or hold with the hands. It may be with the hands or remotely by robotic tools. NIOSH CBRN Cautions & Limitations letter 'T' states direct contact with CBRN agents requires proper handling of the SCBA after each use and between multiple entries during the same use. Proper handling involves prevention of CBRN contamination spread and cross contamination of known clean items. If re-entry is decided while using the same CBRN SCBA, use recommendations should be strictly observed. Handling of contaminated CBRN SCBA should contain and mitigate all forms of CBRN contamination in accordance with the correct procedure relevant to the type of agent exposure. Universal handling procedures, used by hazardous material operators and in accordance with OSHA HAZWOPER requirements, are recommended. Actual handling of contaminated CBRN SCBA requires proper dermal and respiratory protection appropriate to the type of agent exposure. NIOSH-approved CBRN SCBA and NIOSH-approved CBRN APR are recommended as respiratory system protection during handling of contaminated CBRN SCBA equipment scheduled for disposal.

iv. **Individual Equipment Decontamination.**

If known CBRN contamination is present on the CBRN SCBA, the most effective action to do is to go through gross decontamination wash-down with water to remove any visible or detectable type of CBRN agent. CWA will not be neutralized by water but rather diluted to a level and physically washed off given equipment surfaces. It is expected that massive amounts of CBRN particulates will be washed off but trace particulates will likely stay in

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intricate crevices of the CBRN SCBA. Gross decontamination with water is expected to limit CWA agent penetration and permeation. CBRN SCBA, confirmed contaminated by available laboratory results, may produce evidence to use default timing rules where the CBRN SCBA that was suspected of being contaminated is now known to be contaminated or clean and is then used in known contamination for an additional 3- to 5-hours if it was known to be clean or, if dirty, its use is does not exceed the total 6-hour limit.

v. **CBRN SCBA Facepiece Decontamination.**

In Level B OSHA/EPA protective ensemble protection or other recognized consensus standards PPE levels such as NFPA 1991 or 1994 classes, usually only the facepiece, second stage regulator, and hose assembly are expected to be exposed to CBRN contamination. In the process of decontamination, decon methods of wash-down with copious amounts of water may limit the amount of CBRN contamination spread to the remaining areas of the CBRN SCBA. The controlled substitution/replacement of only the contaminated parts of the CBRN SCBA, in an attempt to continue to use the uncontaminated components of the SCBA, would be extremely difficult to prevent cross contamination of the interior air-pressure boundaries and is not recommended.

vi. **CBRN SCBA Cylinder and Hardware Decontamination.**

For biological response, EPA guidance calls for use of adjusted pH bleach on hard surfaces. See the link for additional information on adjusted pH:

<http://www.epa.gov/pesticides/factsheets/chemicals/bleachfactsheet.htm>

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A CBRN SCBA used in a biological response may be decontaminated using soap and water and a neutral 0.5% hypochlorite solution. This solution, close to, but not above, pH of 7 and 5,000 to 6,000 parts per million in strength, can be prepared by mixing one part bleach (5.25%-6.00%) to one part white vinegar, to eight parts clean water. Bleach and vinegar are not combined together at any point in time; rather some water is added to the bleach, then vinegar and then the rest of the water. The pH of the solution must be tested routinely with a paper pH test strip. Ensure pH test strips are available. Treated surfaces must remain in contact with bleach solution for 60 minutes and repeated applications or emersion will be necessary to keep the surfaces wet. Additional, CBRN agent decontamination methods are available at CDC search engine <http://www.cdc.gov/az.do#S>

vii. **Detection Methods In Support of Decontamination Operations.**

To determine the effectiveness of decontamination operations, relevant detection instruments should be used to confirm CBRN agent decontamination has been effective. The current point source or direct read quantitative monitors available for CBRN detection are limited in type and capability. Most of the available technology has limited sensitivity and selectivity. Detection methods using laboratory results to confirm the effectiveness of decontamination is currently, the best recourse. Qualitative monitoring devices such as U.S. Army M8 paper, M9 tape, M256 kit, M256A1 kits, CAM, ICAM, ACADA, or other detection equipment may not provide the degree of quantification necessary to fully determine CWA presence or absence. End users should rely on repeatable results from certified public health or federal laboratories to substantiate key decision processes. In the

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interim, the repeated use of reliable qualitative monitoring devices to help in establishing site control measures and exclusion zones may prove beneficial until quantified results are available. Next generation biological agent detection measures are improving daily but are not field deployed yet at the individual end user level. Radiological agent detectors are available and deemed adequate to quantify dosage, presence and removal of radiological particulates and nuclear fallout.

viii. **Recommendations for Disposal.**

CBRN SCBA, once decontaminated to the best level possible, require special handling for disposal. Users of CBRN SCBA will likely not have the decontamination resources to bring CWA contaminated SCBA to regulatory HAZWOPER levels of agent presence. Users should ensure all types of CBRN SCBA, regardless of type of contamination are triple bagged in appropriate shield material, labeled with the type of agent or agents and the amount/type of gross decontamination solution used. Amount of exposure time for the contaminated SCBA, the concentration and the amount of CBRN contamination is also beneficial information relative to disposal. Adherence to local, state and federal disposal procedures involving incineration, for specific CBRN agents, is required.

- ix. **Cleaning and Sanitization of CBRN SCBA.** A CBRN SCBA contaminated with CWA will not be cleaned and sanitized for any type of re-use. CBRN SCBA contaminated with biological particulates, biological toxin or radiological particulates require detailed decontamination and most likely re-use will not be cost effective depending on the conditions of contamination. Recommended cleaning and sanitization procedures for non-

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contaminated CBRN SCBA follow the same manufacturer guidelines as for traditional SCBA.

Information developed from the World Trade Center response is located at

<http://www.cdc.gov/niosh/respcn.html>

x. **Integration of CBRN SCBA with Protective Suit Ensembles**

1. NIOSH-approved CBRN SCBA are used by all types of emergency responders in EPA Level A, Level B, and Level C protective equipment ensembles and suits, NFPA ensembles and current military mission oriented protective postures/toxic environment protective outfits. They are also used with Explosive Ordnance Disposal (EOD) suits. As of 2005, NIOSH certification programs do not exist for CBRN protective ensembles or for the bench mark suit testing, evaluation and concept development. However, next generation chemical/ biological protective ensembles are being developed by select private sector companies under contract to the Department of Defense and the NFPA. NIOSH/NPPTL only certifies CBRN respirator as systems. NIOSH/NPPTL does not ly certify CBRN protective ensembles or suit assemblies with a NIOSH-approved CBRN respirator.
2. In light of this information, there are several aspects of use that are addressed in the following paragraphs. They focus on chemical suit pass-thru-devices, HAZWOPER Level A, B and C Protections,

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CRUL values while wearing a protective ensemble, CBRN SCBA facepiece interface methods, and EOD suits

*** Industrial Protective Ensemble/Chemical Suit Pass -Thru Devices:**

A. CBRN SCBA, with approved auxiliary hose line assemblies, may interface successfully with stand-alone, integrated, specific chemical suit pass thru devices. These pass-thru devices allow airline connections to literally “pass through” designed suit openings. They normally consist of airline pigtail designs using Hansen, Schrader or Foster connections.

1. A special adapter from select respirator manufacturers is available for Level A suits.
2. Airline pigtail or auxiliary hose line assembly, present on NIOSH-approved CBRN SCBA, may allow CBRN SCBA to have non-compliant, but still acceptable air pressure exchanges in clean airline connections while in a Level A, fully encapsulated ensemble, provided the Level A ensemble is brand new and hydrostatic certified.

NOTE: The pigtail interface is not live agent tested in terms of the mating of an external air line to the pigtail.

3. Use of a chemical suit pass- thru device in CBRN environments, is situation dependent and at the discretion of the incident commander. Currently, NIOSH does not issue CBRN protection approval to chemical suit pass-thru devices. However, the integrated SCBA air line and

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fittings that connect to the pass-thru devices must be NIOSH-approved and that is done typically, in the first tier of approval, if it was correlated to the CBRN SCBA approval process. Interchangeability of the pass-thru device, for purposes of interoperability between manufacturers is not recommended.

*** HAZWOPER Levels A, B, C and D, Protection of the Wearer and How the CBRN SCBA Interfaces.**

A. Industrial hazardous waste operations and emergency response (HAZWOPER) operations pair up different classes of respirators, with different types of protective clothing. The complete outfit, consisting of a respirator, suit, gloves, boots and other necessary accessories, is called an *ensemble*. Protective suit ensembles used in HAZWOPER are commonly described as levels of increasing protection starting at the lowest level of protection, Level D, to the highest level of protection, Level A [OSHA 1997]. As required by OSHA, personal protective equipment must be selected which will protect employees from the specific hazards which they are likely to encounter during their work on-site [OSHA, 1997]. The amount of protection afforded by selected PPE is material-hazard specific and dependent on accurate characterization of the workplace before entry. OSHA/EPA Levels D, C, B, and A are designed to provide increasing levels of dermal and respiratory protection from vapor, liquid, aerosol, and particulate contamination. Levels A and B provide higher levels of respirator and dermal protection than levels C and D. SCBA are required in Levels A or B ensembles. CBRN SCBA meets the OSHA respiratory requirements for HAZWOPER Levels A and B. CBRN SCBA, used in conjunction with a new regular production unit Level A ensemble, are

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expected to stay contamination free, dependent on the quality assurance testing of the suit and local compliance to the applicable OSHA or EPA standard, and if applicable, the NFPA code. However, if the Level A ensemble is compromised thru fair-wear-and-tear (expected to be a possibility in an old RPU), snags, collateral damage from a secondary device, or poor quality construction, the end user should expect the NIOSH-approved CBRN SCBA to continue to provide its accepted standard of performance, even though the interior of the suit ensemble may be harboring dangerous agents.

B. Because Level A is considered burdensome on the wearer, CBRN SCBA are worn, exposed to the ambient atmosphere, in Level B or Level C ensemble configurations, yes, Level C. In some responder communities, head harness straps are worn overtop of protective ensemble hoods. NIOSH-approved CBRN SCBA worn with the head harness of the CBRN SCBA exposed to the ambient atmosphere could jeopardize the intended sealing properties of the CBRN SCBA facepiece and contribute to penetration of the wearer's breathing zone. Please ensure the CBRN SCBA head harness is donned on the user's face and head first and then the protective suit hood is donned overtop of the head harness. Necessary measures to bridge the gap between the respirator's face blank and protective suit hood/neck material should be taken, as deemed appropriate by local ISO/HSO.

Integration of CBRN SCBA with firefighter turn out gear, law enforcement tactical field gear, Level A, B, C and D hazardous waste protective suit ensembles, NFPA 1994 Class 1, 2 or 3 ensembles, and NFPA 1991 ensembles or any other dermal protective barrier/suit used by the incident commander, is a reality now. A direct transfer of the

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common industrial hazardous materials and waste response capabilities to the realm of CBRN incident response makes tactical sense, provided certain improvements and modified tactics, techniques and procedures were identified and made available in current field deployed PPE and next generation regular production protective clothing and respirators. Crisis event commanders may weigh the constraints that Level A or Level B place on the responder and decide, in the interest of mission accomplishment under crisis response, to use CBRN SCBA in Level C for a specific tactical response. If this occurs, NIOSH-approved CBRN SCBA are approved as stand alone respiratory protection systems. How they are integrated with other types or levels of protective ensemble protection is not a NIOSH requirement for certification. NIOSH-approved CBRN SCBA will provide the required level of respiratory protection provided they are used accordingly. NIOSH-approved CBRN SCBA are not currently approved in tandem with any protective suit ensemble or suit sub-component. As discussed, respirator manufacturers outfit SCBA with compatible accessories for SCBA use in protective suit ensembles, such as suit pass-thru devices, auxiliary hose assemblies and Rapid Intervention Team or Crew/Universal Accessory Connection accessories that support SCBA compatibility with protective suit ensembles and portable air sources. Use of these compatible accessories for CBRN incident response is at the discretion of the incident commander or lead federal agency officer in charge.

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*** CRUL.**

A. CBRN Respirator Use life of a CBRN SCBA or CRUL time value does not start unless the protective suit ensemble is breached and allows minor to significant agent entry. Having a CBRN SCBA on under a Level A suit provides a barrier of protection to the CBRN SCBA, but does not change the CBRN Respirator Use Live time value of 6-hours, (CRUL = 6). Granted, the a compliant and tested suit can provide a level of protection (protection factors vary according to suit design and manufacturer) to the CBRN SCBA from splash and vapor hazards, provided it is compliant to current available third party CBRN consensus standards such as NFPA 1994 or 1991, however, if that ensemble is breached by fair wear and tear, snagging, tangle, cutting or penetrating hazards, the interior of that ensemble (Level A or next generations of Level A) may allow hazardous CBRN agents to accumulate and contaminate/expose the emergency responder.

*** CBRN SCBA Facepiece Seal Compromising.**

A. Doffing of protective suit ensemble should not adversely impact the sealing properties of the NIOSH-approved CBRN SCBA, provided doffing actions are not overly severe. An adequate respirator human-face-to-faceblank-seal should be maintained by the end user or by use of the two-man rule/user team, while doffing protective suit ensembles.

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*** Explosive Ordnance Disposal Suits.**

Explosive Ordnance Disposal (EOD) bomb squad suits are designed to provide chemical and biological protection during low threat explosive ordnance detonation or improvised explosive device disposal operations (IED) involving CBRN agents. Select NIOSH CBRN SCBA are compatible for use with EOD suits. NIOSH-approved CBRN SCBA are worn on the outside of the bomb suit. For additional information about EOD suits available to emergency responders see

http://www.med-eng.com/medeng_products_en/medeng_products_display_product.jsp?PID=5

The following links contain relevant information pertaining to protective suit ensembles and respirator integration for CBRN response.

Biological: <http://www.bt.cdc.gov/documentsapp/Anthrax/Protective/10242001Protect.asp>

Chemical: <http://www.bt.cdc.gov/agent/agentlistchem.asp>

Radiological: <http://www.bt.cdc.gov/radiation/pdf/MassCasualtiesGuidelines.pdf>

CHAPTER 8: Summary

Firefighters and emergency responders, such as law enforcement special weapons and tactics teams, use SCBA that are NIOSH-approved, as well as standards developed by NFPA, principally, the NFPA 1981 "code" and others. These standards address certain respirator manufacturer requirements that are unique to firefighting and operations in hazardous atmospheres. In October of 2001, these standards did not address potential CBRN agents which could potentially penetrate or permeate through the SCBA. Analysis of potential hazards and materials of construction of the SCBA in October of 2001, lead to the conclusions that the characteristics of the "facepiece to user" interface required verification for each SCBA marketed to the public workforce. Because gas and vapors are more penetrable than radiological and biological particles, the focus of SCBA CBRN testing was on chemical gas, vapor and aerosol penetration or permeation. Currently, CBRN self-contained breathing apparatus, CBRN SCBA, approved by NIOSH can provide minimum respiratory protection against these agents; however, responders at the site may have only a part of the information necessary to select the type of appropriate complimentary personal protective equipment (PPE) for the response. In the cases where it is an initial response to a suspected CBRN terrorism incident, an actual CBRN incident or a follow on response to a known CBRN incident, protection of the respiratory system is paramount and NIOSH CBRN certified, open-circuit, pressure-demand, self-contained breathing apparatus are highly recommended.

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CBRN SCBA, when contaminated with CBRN G-series nerve agents (GA, GB, GD, GF, GE), V-series nerve agents (VX, Vx, VE, VM, VS etc.), H-series (H, HD, HN etc.) or L-series blister agents (L-1,HL etc.), become *single - use* respirators and have a *maximum use life of six continuous hours*. Remaining types of contamination consisting of toxic industrial chemicals (TIC), toxic industrial materials (TIM), fire debris, blood borne pathogens and biological or radiological particulates are treated in accordance with existing practices. Full, partial or initial characterization of the incident is a critical requirement. Numerous hand held current on-site detection methodologies, to characterize a CBRN incident, use qualitative indicators and are limited in scope. Therefore, not all possible exposure limits in a CBRN incident response are expected to be known initially.

Selection of PPE for CBRN incident response requires a knowledge level commensurate with current experience in wear time, use time, maintenance time and recovery time of PPE. Recent NIOSH Respirator Selection Logic (RSL), dated October, 2004, is not intended to be used in the selection of respirators for protection against infectious agents or for CBRN agents of terrorism. While the industrial respirators identified in the RSL can provide a variable level of protection against some of the irritating military/law enforcement riot control agents, such as CS, CN and pepper spray, they are not live agent tested by NIOSH and can, in fact, exhibit catastrophic failure when exposed to HD or GB while in a confined space. Additionally, the process safety information necessary to use the industrial respirator selection logic (RSL) is generally not available for infectious disease or bioterrorism agents (e.g. defined exposure limits, airborne and dermal concentrations). Likewise, CBRN terrorism events may involve chemical toxic industrial compounds or military grade/terrorism grade chemical warfare agents that can quickly degrade industrial respirator materials, penetrate

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industrial respirator silicon or other material air-pressure boundaries, build up in industrial respirator air-pressure boundary dead-spaces not flushed by exhalation air flow or have an extremely low toxic level that is difficult to quantify and measure on the incident site, resulting in a lack of proper respirator performance.

The guide is intended as a training aid for use of a CBRN SCBA, allow assessment of issued CBRN SCBA and Non-CBRN SCBA and assist in minimizing risk to American emergency response workers. In crisis response, it is expected that incident command risk assessments requiring NIOSH CBRN approved respirators should be invaluable. Actions before, during, and after a chemical, biological, radiological, or nuclear incident require pre-planning and are expected to be incident unique. The individual response to each type of contamination or types of contamination may require initial similar actions en route to the site. However, once on site, actions done to contain, mitigate, evaluate, decontaminate, and close the site may vary by the type of agent or agents present.

The National Personal Protective Technology Laboratory (NPPTL) of the National Institute for Occupational Safety and Health (NIOSH), certifies open circuit, pressure demand, self-contained breathing apparatus (SCBA) respirators for use by emergency responders and other qualified individuals, responding to emergency events involving chemical, biological, radiological or nuclear (CBRN) agents and effects. The US Department of Homeland Security (DHS) sanctioned this equipment certification process and requires the use of NIOSH CBRN approved respirators in the ongoing DHS domestic preparedness equipment grant programs. For more information related to

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CBRN equipment standards adopted by the DHS go to:

http://www.dhs.gov/dhspublic/interapp/editorial/editorial_0420.xml.

NIOSH serves the occupational workforce under the administration of the Centers for Disease Control and Prevention (CDC) of the United States Department of Health and Human Services. NPPTL supports NIOSH with personal protective equipment technology research, respirator certification programs, site audit programs, firefighter fatality evaluation support, and respirator standards and policy development. NIOSH published CBRN SCBA certification standards under 42CFR84, paragraph 84.63, (a), (b) and (c) on December 28, 2001. NIOSH issued its first letter of approval for a civilian CBRN SCBA on May 31, 2002. On February 26, 2004, the DHS adopted the first civilian homeland security personal protective equipment standards for first responders and simultaneously endorsed the use of NIOSH CBRN SCBA, NIOSH CBRN APR, NIOSH CBRN APER, and NIOSH CBRN SCER technical evaluation and certification standards along with five National Fire Protection Association (NFPA) protective equipment documents. DHS made the NIOSH and NFPA standards qualifying criteria for processing homeland security equipment preparedness grant applications and purchases.

NIOSH CBRN SCBA approval letters are based on documented passing minimum laboratory performance requirements through rigorous tests and stringent evaluation of manufacturer quality-control practices, technical specifications, and other supporting documentation. A NIOSH CBRN protection approval signifies that an SCBA is certified by NIOSH to provide respiratory protection against airborne CBRN agents. Prior to NIOSH approval, the CBRN SCBA undergoes a compliance

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part number review before and after NIOSH live agent testing. This NFPA review and limited testing as necessary, is managed by the private firm, Safety Equipment Institute (SEI), in accordance with the National Fire Protection Association 1981, non-profit organization consensus document, for protection against structural fire hazards. SEI label appears on all NIOSH-approved CBRN SCBA. The CBRN SCBA approval requirements are designed to meet the stated consensus respiratory protection needs of emergency responders.

The recent TIC and improvised explosive devices discovered in Fallujah, Iraq, demonstrate how military personnel are using NIOSH-approved SCBA overseas. [Combined Press Information Center, November 26, 2004]. Reports show US military forces uncovering clandestine Iraqi chemical laboratory operations inside an urban building in Fallujah, Iraq. Industrial chemicals were found adjacent to improvised explosive device parts and blasting caps. SCBA with Level C ensembles were used by military personnel during the Fallujah investigation. The personnel exhibited proper wearing of NIOSH approved SCBA with protective ensemble. Additionally, in May of 2004, military forces in Iraq, uncovered improvised explosive devices attached to Iraqi 155mm artillery ammunition rounds that reportedly contained binary forms of nerve agent [USA Today, May 18, 2004]. These are indicators of a working/developing threat from CBRN agents.

Donning a CBRN SCBA quickly and wearing it correctly will prevent respiratory exposures to ambient concentrations of CBRN agents even under the most extreme conditions of confined space. This guide assists the user in determining what he or she needs to know regarding CBRN SCBA

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certification and compliance to support their mission. NIOSH cautions and limitations play a pivotal role in establishing the working use life of NIOSH CBRN SCBA.

The purpose of this document was to provide emergency responders with practical guidance on the recommended proper use of NIOSH certified CBRN SCBA for protection against CBRN agents. It has been accomplished thru various means. One, the publication of this guide, two, the publication of current certified equipment listings (CEL), and three, the use of NPPTL web pages to disseminate appropriate guidance.

A list of current CEL approvals is available at:

<http://www.cdc.gov/niosh/npptl/topics/respirators/cbrnapproved/scba/>

NIOSH continues processing CBRN SCBA applications in the technical certification (TC-13F-) SCBA respirator schedule. Over the course of the next three years, NIOSH expects to provide respirator manufacturers the opportunity to have various classes of CBRN respirators approved and consequently continue to contribute to the national certified respirator inventory. This should allow manufacturers to offer end users a greater variety of respirators for different types of potential CBRN respiratory occupational workplace needs.

A CBRN closed circuit SCBA concept paper was published on October 30, 2004. Future CBRN concepts for combination open circuit SCBA with combination capabilities of supplied air and air-purifying modes are projected. For more information on new types of CBRN respirators in concept

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development go to the following links: <http://www.cdc.gov/niosh/npptl/standardsdev/cbrn/scba/cc-scba/concepts/cc-scbacon103004.html> and <http://www.cdc.gov/niosh/npptl/standardsdev/cbrn/papr/>.

Intentions for Use

NIOSH CBRN SCBA respirators are intended for use by trained emergency responders for specific entry into or escape from unknown, known, suspected, or partially characterized CBRN hazardous environments. A hazard is defined by OSHA as the inherent capacity of a substance to cause an adverse effect [OSHA, 2003]. The DHS NRP defines a hazard as something that is potentially dangerous or harmful, often the root cause of an unwanted outcome. Defining a hazard helps in defining how to respond to it. Emergency responders could respond to single, multiple or combination CBRN hazards. Safe incident response requires the use of appropriate personal protective equipment. CBRN SCBA respirators are part of the range of PPE selection. At a CBRN emergency response hazardous event, respirators providing the highest level of protection should initially be used, and routinely used, as the mission dictates, until hazard types and concentrations are quantified and exposures are determined to be compatible with less protective CBRN respirators. Currently, the respirator configuration that offers the highest level of respiratory protection and inherent facial dermal protection is the NIOSH CBRN SCBA. Emergency responders and first receivers should use CBRN SCBA in conjunction with personal protective ensembles that provide appropriate levels of protection against dermal hazards.

A joint OSHA and NIOSH interim guidance document was published on the internet, August 30, 2004. It provides CBRN PPE selection matrix guidance based on potential toxicological levels of

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exposure. It defines red (hot), yellow (warm) and green (cold) zones and provides PPE recommendations for each zone, as they relate to CBRN contamination. The link to the joint OSHA/NIOSH CBRN PPE selection matrix is:

<http://www.osha.gov/SLTC/emergencypreparedness/cbrnmatrix/index.html>.

CBRN Respirator Use Life (CRUL)

Quantification of known contamination on an SCBA starts with repeatable detection and sampling plans in place and conducted. Once contamination is confirmed or closely estimated, the administrative clock can start allowing safety coordinators to determine estimated contamination times and generate a time of use start point for a respirator use life, similar to a service life, but not identical. The purpose for NIOSH creating a CBRN Respirator "Use Life" (CRUL) concept is to provide a guidance tool, in the case of the SCBA, to properly distinguish actual CBRN use from more common SCBA use terms related to service life or rated service time of the SCBA. The CRUL for a CBRN SCBA incorporates the known rated service times and system service life concepts and overlays the NIOSH CBRN SCBA cautions and limitations, to create practical use life guidance that provides maximum protection to the end user from the permeating and penetrating effects of chemical warfare agents.

CBRN Respirator Use life assists in defining 4 variables: 1) how long a CBRN SCBA can be used based on the initial exposure to CWA, 2) how long the actual duration of use is dependent on real time use, 3) how long a contaminated CBRN SCBA can be used while it is contaminated or assessed as

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potentially contaminated and 4) when to discard the respirator. Rated service time of the cylinder dictates the amount of air available to the end user per one full air cylinder. CBRN SCBA, with refilled cylinders, has a CRUL of 6-hours. Contaminated respirators must be grossly decontaminated. The use of copious amounts of controlled water spray and runoff control is recommended before double bagging for disposal. A CBRN SCBA should be discarded/disposed of when a system is found contaminated or components such as facepieces, head harnesses, seals or hoses are altered due to CBRN exposure.

CBRN Respirator Use life for a CBRN SCBA is based on understanding and implementing the NIOSH listed cautions and limitations. An approved CBRN SCBA has 10 NIOSH required cautions and limitations applicable to the approved CBRN SCBA. They are lettered, rather than numbered, because the letters follow NIOSH alphabetical listings of cautions and limitations already in existence plus any new letters assigned to the statement of standard cautions and limitations.

In the CBRN SCBA case, the cautions and limitations are I, J, M, N, O, S, Q, R, T and U. Of those ten listed, four (4)-cautions and limitations (Q, R, T, & U) are specifically for CBRN response. All ten are published in the approval label as a paper insert to the user instructions issued with the CBRN SCBA.

The ten cautions and limitation sentences and paragraphs are designed to ensure minimum safety performance measures are integrated into the use of the respirator for the end user. In the process of using those cautions and limitations, a use life plan and practice for a contaminated CBRN SCBA can

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be developed by on scene commanders, safety coordinators and other personnel to aid in the determination of when and how to discard contaminated CBRN SCBA.

The use life concept of a continuous 6-hour period, beginning at the time of a confirmed CWA exposure, applies to the NIOSH CBRN SCBA currently. This is because the CBRN SCBA respirators are the only NIOSH approved respirators that have disposal recommendations written in the approved NIOSH cautions and limitations. Real time response actions will dictate actual use life parameters. It is expected to be understood that the detection of chemical warfare agent (CWA) contamination, is the key to determining a 6-hour start point of a CBRN SCBA CRUL. Therefore, calibrated instruments which are designed to reliably quantify CWA at known limits of detection should be available for use. Reliable qualitative detection instruments may be used to determine the presence or absence of chemical warfare agents but these same qualitative detection means (M8, M9 paper and M256A1 kits) are not ideally suited for determining contamination concentration/presence in the breathing zones of CBRN SCBA or the effects of penetration/permeation on CBRN SCBA.

If on-site or remote detection instruments are not available, in place CBRN agent sampling procedures and the means to transport those samples to qualified laboratories should be options available to the incident commander. These laboratories can then generate quantifiable results detailing the presence or absence of confirmed CBRN contamination or the lack of it. Once detection monitoring confirms CWA at the site, the CBRN SCBA use life of 6-hours starts. A local, state or federal qualified public health laboratory should have the means and capability to confirm the CBRN agent type and quantity of agent present, provided the sample chain of custody is maintained. The actual use life start point

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time for a contaminated SCBA will likely require backward or forward time adjustment based on the verified public health laboratory results.

Use beyond the 6.0 hour "limit" in a confirmed chemical warfare agent incident violates NIOSH Caution and Limitation "U". However, in a real world use, the incident commander may be confronted with the decision to implement use beyond the 6.0 hour mark due to extenuating circumstances of potentially or actual "vapor only" exposed CBRN SCBA. For example, the need to rescue and recover victims combined with a shortage of clean CBRN SCBA may support a decision to extend use of the CBRN SCBA units not exposed to liquid agent. This might be one example of the need to re-use vapor only exposed CBRN SCBA. The incident commander should determine at the 5.5 hour mark of a 6.0 hour CBRN SCBA use life plan, if the possibility of continued chemical warfare agent permeation or penetration is significant or if the ambient exposure has been substantially eliminated by immediate technical gross decontamination techniques conducted and decontamination confirmed by samples submitted to for public or federal health laboratory analysis. Examples of information links concerning emergency preparedness of public health laboratories are <http://www.bt.cdc.gov/lrn/chemical.asp> and http://www.aphl.org/Emergency_Preparedness/index.cfm. These information links and procedures emphasize the need for rapid and reliable CWA measurement techniques.

Expedient decontamination operations may maintain use life and allow additional use life time out of the same CBRN SCBA if vapor only conditions are known and the SCBA is expediently washed down after a given entry and exit. Furthermore, accurate detection is vital to isolating specific contaminated number of respirators as opposed to isolating the entire shift of responder used respirators that might or might not have been contaminated above an available permissible exposure limit or other

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recognized occupational exposure limit for the given contaminant or contaminants. Since sulfur mustard (HD) agent toxicology and effects are highly persistent, modifications of the 6-Hour use statement in caution and limitation U is not recommended and therefore, not permitted when HD is the agent of exposure. Rapid decontamination techniques involving physical removal of HD contamination from the SCBA will decrease agent concentration, relative to agent contact time. This is why timely decontamination operations are important.

The use life of a CBRN SCBA after exposure to a CWA, explicitly means **six continuous hours in a single shift, day, or event**. Therefore, the use life of a CBRN SCBA is not 6 individual 1-hour exposures in one shift or one day, nor does it 6 different 1-hour exposures over the course of 6 different days. None of these example variations apply and other variations presented at the time of the incident response are also expected not to apply, if they deviate from the central use life theme of maintaining NIOSH CBRN protection approval for 6 continuous hours, beyond initial exposure.

CBRN SCBA User Guidance: Before, During and After Operations Actions

Trained first responders, emergency responders and first receivers routinely conduct pre-checks, in-process checks and post-checks of all issued and collective equipment used in route, on scene and off site. In an effort to categorize these actions into a user-friendly format relative to CBRN agent responses, information is outlined in this guide as before, during and after operations actions. This is recommended guidance to better support end user understanding, provide a written source for training purposes and a format for future NIOSH guidance documents. Manufacturer's user instructions

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published at the time of issue of the CBRN SCBA have been consulted in the development of this guidance.

This perspective has resulted in tailored guidelines describing CBRN SCBA use before operations, during operations, and after operations while integrating pertinent NIOSH CBRN SCBA cautions and limitations appropriately.

All use actions for CBRN SCBA are centered on the following 4 facts, that once CWA contaminated,

- 1) CBRN SCBA are single use,**
- 2) CBRN SCBA have a maximum of 6.0 continuous hours of use life,**
- 3) CBRN SCBA are decontaminated as expediently as possible prior to disposal to prevent the spread or penetration of contamination to other personnel or equipment and**
- 4) All direct contact with CBRN agents require proper handling of the CBRN SCBA after each use and between multiple entries during the same use.**

In April, 2005, the EPA released a compilation of available data on building decontamination alternatives. In this document, EPA discusses how a decontamination agent is registered with EPA, how EPA grants a crisis exemption allowing a specific decontamination agent to be used and types of liquids, foams, gels, gases and vapors the EPA has assessed as possible decontamination technologies for decontaminating buildings following an attack using chemical or biological agents. [EPA, 2005]. Decontamination processes based on adjusted bleach pH have been demonstrated by the EPA as providing up to 6 logs of kill for biological agents with sufficient residence time on porous or hard surfaces. Six technologies are applicable to both chemical and biological agents while 5 additional

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technologies are specific to biological agent decontamination. See the EPA publication entitled Compilation of Available Data on Building Decontamination Alternatives, Office of Research and Development, National Homeland Security Research Center, EPA, April, 2005. The following links provide links concerning adjusted bleach pH decontamination and other advancing technologies:

<http://www.fema.gov/txt/areyouready/areyouready.txt>

<http://ehp.niehs.nih.gov/members/1999/107p933-974munro/munro-3.html>

<http://www.epa.gov/etv/verifications/testqa-index.html#bdt> .

CBRN SCBA Integration with Protective Suit Ensembles

CBRN SCBA are NIOSH-approved as stand alone respiratory protection devices and not in tandem with any model or type of protective suit ensemble, overgarment or suit sub-component. Select industrial approvals may incorporate protective suits or suit components as industrial rated accessories but these are not CBRN approved. Protective suit ensembles used in hazardous waste operations (HAZWOPER) and hazardous materials (HAZMAT) emergency response operations, commonly known as Level A, Level B, Level C and Level D are recognized by OSHA to provide increasing levels of dermal and respiratory protection from liquid, aerosol and particulate contaminants, with Level A being the greatest amount of protection afforded. Per OSHA, Levels A and B, require that SCBA be used and are understood to provide higher levels of respiratory protection than levels C and D. Field use shows that modifications of those levels of protection do exist. Level C suit with a SCBA is common in law enforcement response operations. CBRN SCBA can be worn in Levels A or B and are being worn with Level C ensembles. Crisis response incident commanders will not be regulated

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by OSHA in crisis response. They weigh the mission risk versus a given level of protection provided by equipment and should opt to use CBRN SCBA in Level C for a specific response because Level A or B are non-tactical or responders may not have Level A or B immediately available for time critical functions such as life saving or crime scene management.

The Use of CBRN SCBA versus non-CBRN SCBA respirators with firefighter turn out gear, law enforcement field gear, OSHA/EPA Level A, B, C and D ensembles, NFPA 1994 Chemical/Biological Terrorism Incident class 1, 2 or 3 ensembles or any other dermal protective barrier recognized by the U.S. Department of Homeland Security depends on the selection criteria used by a incident commander. Selection of respirator and protective suit ensemble combinations hinges on many variables some being the environmental conditions of the site, whether the CBRN agent is unknown or known and whether the agent concentration can be characterized. Use of a Non-CBRN/Industrial SCBA with a Level A ensemble, while seeming practical, is actually a lesser form of respiratory protection in a CBRN environment. If the Level A suit is compromised, the inside of that Level A suit will likely turn into an exposure chamber and warrant the increased respiratory protection that only a CBRN protected SCBA can provide. What to use, when to use it, how to use it and the underlying question of why to use it are the types of use questions for a response to a CBRN terrorism incident.

Currently, respirator manufacturers outfit SCBA with compatible accessories such as pass thru devices that support SCBA compatibility with protective suit ensembles and portable air sources. CBRN SCBA are equipped with Rapid Intervention Team (Crew)/Universal Air Connection (RIT/UAC) accessories that support SCBA compatibility with protective suit ensembles and portable air sources.

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Use of the RIT/UAC or Pass Thru device in an actual CBRN contaminated atmosphere is at the discretion of the incident commander or lead federal agency.

Future Generation Concepts

NIOSH offers CBRN protection approval for several other types of respirators. They are available as manufacturers gain NIOSH CBRN protection approval. They include the tight fitting, full-facepiece air-purifying respirators (APR) for emergency responders and a self-contained escape respirator (SCER) and air-purifying escape respirators (APER) for use by general working populations.

Anticipated future respirator approvals will include the CBRN powered air-purifying respirators (PAPR), CBRN closed circuit SCBA and CBRN combination SCBA/air-purifying respirators.

NIOSH is continuing its efforts in publishing special hazard CBRN use guides and intends to generate peer reviewed documents pertaining to various classes of CBRN approved respirators. The guides will utilize NIOSH public CBRN statement of standards as technical performance references.

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APPENDIX A. Definitions and Glossary

Agent—A force or substance that causes change or effects on an exposed substrate, i.e., a chemical agent.

Airborne Exposure Guideline Level (AEGL) – Published by the National Research Council and Environmental Protection Agency, AEGL characterize the risk to the general population during a one-time accident and emergency scenario with time limits not to exceed 8-hours. The AEGLs represent threshold exposure limits for the general public and are applicable to emergency exposure periods ranging from 10 minutes to 8-hours (AEGL-1, AEGL-2, AEGL-3 and AEGL-4). AEGL are used by NIOSH for CBRN SCBA breakthrough criteria establishment.

Assigned Protection Factor (APF) — OSHA proposed rule, dated June 6, 2003, develops proposed APF and MUC definitions. This CBRN APF definition is an interim definition subject to the final OSHA ruling.

CBRN APF: CBRN APF is the level of protection that a respirator provides in the workplace determined by the known assigned protection factor for that respirator. The CBRN APF of 10,000 is a minimum anticipated, known or simulated workplace factor study level of protection value, expected by a properly functioning respirator, or class of respirators, to a percentage (95% or higher) of properly fitted and trained human test subjects. In accordance with OSHA 29 CFR 1910, 1915, and 1926, June 6, 2003, employers must not apply maximum use concentrations (MUCs) to conditions that are immediately dangerous to life or health (IDLH), instead, they must use respirators listed for IDLH conditions. The CBRN SCBA is a respirator listed for IDLH conditions, unknown conditions, less than IDLH conditions and escape from IDLH conditions. For those situations where exposures are quantified and known to be below IDLH or LEL levels, maximum use

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concentration equations can be applied. The maximum use concentration (MUC) of exposure for a respirator is generally determined by multiplying a contaminant's occupational exposure limit (OEL) by the APF assigned to the specific class or type of respirator. The equation is $MUC = OEL \times APF$. The maximum use concentration is the maximum ambient level of a hazardous substance in which employees can use the respirators [OSHA, 2003]. The MUC is a multiplication product of the exposure limit, specified for the hazardous substance, times the respirator's APF.

MUCs are effective only when the employer has a continuing, effective respiratory protection program as specified in 29 CFR 1910.134. The OSHA 29 CFR 1910, 1915 and 1926, June 6, 2003, proposed rule does defer to respirator manufacturers when the manufacturer recommends a lower MUC for their respirators under specific hazardous substance conditions. An OEL can be a NIOSH recommended exposure limit (REL), an OSHA permissible exposure limit (PEL), a short term exposure limit, ceiling limit, peak limit, or any other recognized exposure limit for a hazardous substance.

The APF for a CBRN SCBA, under emergency conditions, is 10,000, provided QNFT is used to determine the fit factor. The CBRN SCBA retained the traditional industrial SCBA APF. The CBRN SCBA is capable of providing adequate respiratory protection against a contaminant concentration up to 10,000 times the exposure limit for that contaminant under emergency conditions. Additional experimentation is required to determine if a CBRN SCBA would or could be assigned a higher APF, due to the CBRN SCBA exhibiting much greater resistance than an industrial SCBA to the direct application of GB and HD agents and offering a higher percentage of fitted human test subjects trials based on a 95th percentile LANL panel distribution of federal human test subjects tested against corn-oil particulate.

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Biological Agents - Biological agents are bacteria, viruses, or toxins derived from biologic material. Airborne biological agents could be dispersed in the form of liquid aerosols or solid aerosols (a powder of bacterial spores, for example). Biological agents are classified according to biological type, use, operational effects, and physiological actions. Biological agents can be classified as pathogens, toxins, or other agents of biological origin, such as bioregulators or biomodulators.

Blister Agents (Vesicants) —Vesicants are highly reactive chemicals that combine with proteins, DNA, and other cellular components to result in cellular changes immediately after exposure or delayed after exposure. The most commonly encountered clinical effects include dermal (skin erythema and blistering), respiratory (pharyngitis, cough, dyspnea), ocular (conjunctivitis and burns), and gastrointestinal (nausea and vomiting). Blister agents are H (sulfur mustard), HD (distilled sulfur mustard), nitrogen mustard (HN-1, HN-2, HN-3) and Lewisite (L, L-1, L-2, L-3).

Bunker Gear/Turnout Gear/Fire Fighter Protective Ensemble (FFPE)—Protective clothing for structural firefighters that is designed to protect against the thermal environments experienced during structural firefighting. Usually consisting of a jacket and trousers, bunker gear is not appropriate for proximity firefighting. Additionally, bunker gear is not a recognized ensemble for full protection against CBRN agents. Expedient use of bunker gear, with fire helmet, CBRN SCBA, fire gloves and fire boots, to escape from CBRN contamination or an ensuing CBRN incident, is a field expedient form of protecting fire emergency responders from the respiratory hazards of a CBRN incident but is not considered, by NIOSH, as an example of a protective ensemble that provides appropriate levels of protection against dermal hazards of CBRN agents, as stated in NIOSH CBRN Caution and Limitation “Q”.

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CBRN — An NIOSH-approved protection meaning chemical, biological, radiological, nuclear agents and required to be listed on the NIOSH label for a CBRN SCBA. Specific CBRN cautions and limitations apply once the respirator is prepared and used for CBRN incident response. Other examples of a NIOSH-approved protection are “SC” for Self-Contained and “PD” for Pressure-Demand. These protection categories are used together in the protection column of a NIOSH label as *SC/PD/CBRN 60 min 4500 psig*.

CBRN Self Contained Breathing Apparatus (SCBA): An Open Circuit, Pressure-Demand, Entry and

Escape SCBA - An atmosphere-supplying respirator for which the breathing air source is designed to be carried by the user. In the CBRN SCBA case, it is an atmosphere-supplying respirator for which the breathing air source is designed to be carried by the user and consists of a full-face, tight fitting facepiece with or without approved accessories on a SCBA found compliant to NIOSH 42 CFR 84, NFPA 1981 code, NIOSH CBRN SCBA special tests and displaying the NIOSH *CBRN Agent Approved* adhesive label on the backframe assembly of the SCBA.

Chemical Warfare Agents (CWA): Chemical warfare agents are agents specifically intended for military warfare operations to kill, seriously injure or incapacitate people. In the context of the CBRN SCBA cautions and limitations “T” and “U” pertaining to equipment contamination, the chemical warfare agents are the nerve agents: GB (Sarin), GA (Tabun), GD (Soman), GF (cyclohexyl Sarin), and VX; and the blister agents: H (sulfur mustard), HD (sulfur mustard), nitrogen mustard (HN-1, HN-2 and HN-3) and Lewisite (L, L-1, L-2 and L-3).

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Class 1 Ensemble, NFPA — Note- As of 2005, this NFPA ensemble level is up for revision by NFPA. In accordance with NFPA 1994 Standard on Protective Ensemble for Chemical/Biological Terrorism Incidents, 2001 Edition, which sets NFPA code performance requirements for protective clothing used at chemical and biological terrorism incidents, Class 1 ensembles offer the highest level of protection. Class 1 ensembles are intended for the worst-case circumstances, where the substance involved creates an immediate threat, is unidentified, and of unknown concentration. Such situations may exist under three scenarios: where there is still an on-going release with likely exposure, the responder is close to the point of release, or most victims in the area appear to be unconscious or dead from exposure. Stay times in the hazard zone are likely to be very short and limited to the breathing air available from the CBRN SCBA. Note: NFPA 1994, 2001 edition, is under revision at the time of publication.

Class 2 Ensemble, NFPA —In accordance with NFPA 1994 Standard on Protective Ensemble for Chemical/Biological Terrorism Incidents, 2001 Edition, Class 2 ensembles offer an intermediate level of protection. Class 2 ensembles are intended for circumstances where the agent or threat has generally been identified and where the actual release has subsided. Conditions of exposure include possible contact with residual vapor or gas and highly contaminated surfaces at the emergency scene.

Class 3 Ensemble, NFPA — In accordance with NFPA 1994 Standard on Protective Ensemble for Chemical/Biological Terrorism Incidents, 2001 Edition, Class 3 ensembles offer the lowest level of protection. Class 3 ensembles are intended for use well after the release has occurred or in the peripheral zone of the release scene for such functions as decontamination, patient care, crowd control, and clean-up. Class 3 ensembles should only be used when there is no potential for vapor or gas exposure and exposure to liquids is

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expected to be incidental through contact with contaminated surfaces. Class 3 ensembles must cover the individual and it is preferred that this clothing also cover the wearer's respirator to limit its potential for contamination. Because these ensembles are intended for longer wear periods, the use of air-purifying respirators with these suits is likely.

Cold Zone/Green Zone/Clean Zone—The cold zone is an uncontaminated area where workers are unlikely to be exposed to hazardous substances or dangerous conditions. This is the area where the command post and support functions that are necessary to control the incident are located. This is also referred to as the clean zone, green zone or support zone in other documents.

Contaminated—Contaminated is an adjective that describes the known condition of an item of personal protective equipment, such as a CBRN contaminated SCBA. If the item is said to be CBRN "contaminated" it is understood that it has been or is being exposed to the deposit, absorption or adsorption liquid, vapor, aerosol or particulate chemical, biological, radiological or nuclear agent/effects or byproducts of CBRN waste. The CBRN persistent contamination is still present, off gassing, or traces of a non-persistent CBRN agent are still possible. This condition is normally attributed to active use in known CBRN response environment, but it may also occur as a result of contamination transfer from a dirty/contaminated item of PPE to a clean item of PPE. A contaminated CBRN SCBA must be handled, decontaminated, and disposed of in accordance with the NIOSH CBRN SCBA cautions and limitations "I, J, M, N, O, S, Q, R, T, and U". CBRN respirator 6-hour continuous use life limitation (CRUL = 6) applies when the exposure is to any of the listed chemical warfare agents.

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Decontamination— A simplified or complicated process intended to make PPE safe for continued use, limited re-use or disposal by decreasing the amount of contamination on an object, or area through the actions of absorption, neutralization, detoxification, destruction, aeration/ventilation, or physical removal of known or suspected contamination. Compounds that are used for decontamination are known as decontamination agents.

Dirty Bomb — Is a conventional explosive device surrounded by or contaminated with some form of radioactive material and designed or intended to disperse the radioactive isotopes upon detonation.

Encapsulated Ensemble— The encapsulated ensemble provides liquid-tight, vapor-tight, and/or gas-tight protection depending on design and compliance testing. The elements of an encapsulating ensemble are garments, hoods, gloves, and footwear that provide protection to the upper and lower torso, head, hands, and feet and completely cover the wearer and the wearer's SCBA or supplied air respirator. OSHA describes it as a totally-encapsulated chemical protective suit (TECP suit) and defines it as a full body garment constructed of protective clothing materials that cover the wearer's torso, head, arms, legs and respirator; may cover the wearer's hands and feet with tightly attached gloves, boots and completely encloses the wearer and respirator by itself or in combination with the wearer's gloves and boots. CBRN SCBA provide respiratory protection to wearer's in encapsulated ensemble.

Event of National Significance— Major events, as determined by the President of the United States, that are vulnerable to terrorism and other criminal acts.

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Exposure— The act or instance of exposing PPE or the human respiratory system to direct CBRN agents or their effects by removing protection or the protection being compromised as a result of being subject to some detrimental effect or harmful condition such as CBRN contamination. Being contaminated does not mean you are necessarily exposed.

Emergency Responder/Emergency Response Provider: Per the DHS, emergency responder or emergency response provider includes federal, state, local, and tribal emergency public safety, law enforcement, emergency response, emergency medical-including hospital emergency facilities, and related personnel, agencies, and authorities.

First Responder: Per the DHS, local and nongovernmental police, fire and emergency personnel who, in the early stages of an incident, are responsible for the protection and preservation of life, property, evidence, and the environment, including emergency response providers as defined in Section 2 of the Homeland Security Act of 2002, as well as emergency management, public health, clinical care, public works, and other skilled support personnel- such as equipment operators, who provide immediate support services during prevention, response, and recovery operations. First responders may include personnel from Federal, State, local, tribal or nongovernmental organizations.

Fit Factor: A quantitative estimate value of the fit of a specific respirator facepiece to a specific individual and typically estimates the ratio of the concentration of a substance in ambient air to its concentration inside the respirator when worn properly.

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Fit Test: The use of a specific measurement protocol to qualitatively or quantitatively evaluate the fit of a respirator on an individual. See also qualitative fit test (QLFT) or quantitative fit test (QNFT)

HAZMAT Team—A hazardous materials response team organized and designated by the employer, that is expected to perform work to handle and control actual or potential leaks or spills of hazardous materials requiring possible close approach to the substance. The team members perform responses to releases or potential releases of hazardous substances for the purpose of control or stabilization of the incident. A HAZMAT team is not a fire brigade nor is a typical fire brigade a HAZMAT team. A HAZMAT team, however, may be a separate component of a fire brigade or fire department. HAZMAT teams are expected to be follow-on responders or first responders to a CBRN incident.

Hot Zone/Red Zone—An exclusion zone that uses a determined administrative cordoned area surrounding a dangerous goods incident, and designed to be an all-encompassing zone signifying highest hazardous contamination or situation of the site, and extending far enough in a determined or flexible distance to prevent any immediate adverse effects from contamination on personnel downwind or adjacent to the zone. The hot/red zone is the innermost exclusion zone of a three layered administrative zone system. They involve hot, warm and cold zones/red, yellow and white zones that provide administrative controls for CBRN contamination detection, site stabilization, crime scene evidence recovery, contamination containment, contamination mitigation, contaminate decontamination, site evacuation/shelter in place, command and control and logistics re-supply operations. Entry is controlled and proper PPE is required to operate in the red zone. This zone is also referred to as an exclusion zone, hot zone or restricted zone. Historically, there is precedence that the actual use of the term “hot zone” or “hot lab” applies to biological contagions only.

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Preston [1994], McCormick et.al. [1996] For the purposes of this document, hot zone includes all hazards of CBRN agents, whether they are independent or multiple.

Incident Command System (ICS) and Incident Commander (IC)—A system and command designate for managing emergencies.

Immediately Dangerous to Life or Health (IDLH): Conditions that pose an immediate threat to life or health or conditions that pose an immediate threat of severe exposure to contaminants, such as radioactive materials, which are likely to have adverse cumulative or delayed effects on health. (See Section h. Other Hazardous Atmospheres in Chapter 2 for more information on IDLH conditions).

Laboratory Respirator Protective Level (LRPL) Testing—A NIOSH-approved CBRN respirator certification test using human test subjects to ensure that the facepiece seal interface between the test subject and the SCBA performs to an established protection level in a quantified laboratory chamber filled with a specific amount of corn-oil aerosol particulates. The LRPL test is conducted using 11 exercise movements on a Los Alamos National Laboratory panel of facepiece sizes for human test subjects, which approximates the facial shapes and sizes of the user population at the 95th percentile.

Level A Ensemble/Protection— The EPA personal protective equipment ensembles identified as Level A, B, C, or D are based on their levels of protection. These ensembles are listed in Appendix B of the OSHA HAZWOPER Standard 29 CFR 1910.120, and in the *NIOSH Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities* (1985). **Level A** represents the greatest danger of respiratory, eye

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or skin damage from hazardous vapors, gases, particulates, sudden splash, immersion or contact with hazardous materials. A Level A ensemble consists of total encapsulation in a vapor tight chemical suit with self-contained breathing apparatus (SCBA) or supplied air and appropriate accessories.

Level B Ensemble/Protection— The EPA personal protective equipment ensembles identified as Level A, B, C, or D are based on their levels of protection. These ensembles are listed in Appendix B of the OSHA HAZWOPER Standard 29 CFR 1910.120 and in the *NIOSH Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities* (1985). **Level B** situations call for the highest degree of respiratory protection but a lesser need for skin protection. It calls for SCBA or positive pressure supplied air respirator with escape SCBA, plus hooded chemical resistant clothing (overalls and long sleeved jacket; coveralls; one or two piece chemical-splash suit; or disposable chemical-resistant coveralls).

Level C Ensemble/Protection— The EPA personal protective equipment ensembles identified as Level A, B, C, or D are based on their levels of protection. These ensembles are listed in Appendix B of the OSHA HAZWOPER Standard 29 CFR 1910.120 and in the *NIOSH Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities* (1985). Level C protection should be selected when the type of airborne substance is known, concentration measured, criteria for using air-purifying respirators met, and skin and eye exposure is unlikely. Periodic monitoring of the air must be performed. Level C ensembles include a full-face or half-mask, air-purifying respirator, Chemical resistant clothing (one piece coverall, hooded two piece chemical splash suit, chemical resistant hood and apron, disposable chemical resistant coveralls.), gloves and boots.

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Level D Ensemble/Protection— The EPA personal protective equipment ensembles identified as Level A, B, C, or D are based on their levels of protection. These ensembles are listed in Appendix B of 29 CFR 1910.120 and in the *NIOSH Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities* (1985). Level D is primarily a work uniform and is used for nuisance contamination only. It requires only coveralls and safety shoes/boots. Other PPE is based upon the situation (types of gloves, etc.). It should not be worn on any site where respiratory or skin hazards exist.

Levels of Protection—Refers to the levels of respiratory and dermal (skin) protection that an ensemble provides such as Level A, Level B, Level C or Level D. A level of protection refers to both the clothing and the respiratory devices inclusive. These levels are defined by OSHA as it relates to respiratory protection and accepted by response organizations such as the U.S. Coast Guard and the EPA.

Live Agent Test (LAT)—Common term used to describe a CBRN respirator certification test that measures CWA permeation and penetration resistance against actual or “live” Sarin vapor and aerosol (GB) or sulfur mustard (HD) liquids, vapors and aerosol. GB LAT or HD LAT describe what phase of testing the respirator is in or completed.

Maximum Use Concentration (MUC): The maximum atmospheric concentration of a hazardous substance from which an employee can be expected to be protected when wearing a respirator, and is determined by the assigned protection factor of the respirator or class of respirators and the exposure limit of the hazardous substance. The MUC usually can be determined mathematically by multiplying the assigned protection factor (APF) specified for a respirator by the NIOSH recommended exposure limit (REL), permissible exposure

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limit, short term exposure limit, ceiling limit, peak limit, or any other exposure limit used for the hazardous substance. Use of MUC is for less than IDLH.

National Institute for Occupational Safety and Health (NIOSH)/The Institute—NIOSH is the federal agency responsible for conducting research and making recommendations for the prevention of work-related injury and illness. NIOSH is part of the Centers for Disease Control in the Department of Health and Human Services.

National Personal Protective Technology Laboratory (NPPTL)—Part of NIOSH, the mission of NPPTL is to prevent work-related injury and illness by ensuring the development, certification, deployment, and use of personal protective equipment and fully integrated intelligent ensembles. NPPTL operates the national certification program for civilian respirators used in all types of workplace environments.

CBRN Approved—A NIOSH certification term that signifies specific respirator systems that have been evaluated, reviewed, and approved/certified by NIOSH as providing an acceptable level of protection against chemical, biological, radiological, and nuclear agents. Approval authority authorized by existing policy of 42 Code of Federal Regulation, Part 84 (42CFR84) and the statement of standard that utilizes the three tier approval process for issuing a CBRN protection approval for a SCBA.

NIOSH-Approved-Is an adjective describing a respirator system and its accessory components that have been reviewed and certified by NIOSH in accordance with 42 CFR Part 84 and determined approved for use

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by the general public in defined workplaces. Approval authority is set up by 42 CFR Part 84 to cover all of industry and, therefore, issued approvals are in support of OSHA.

Nerve Agents—Nerve agents consist of a group of very toxic organophosphate chemicals specifically designed for military warfare. Nerve agents are GB (Sarin), GA (Tabun), GD (Soman), GF (Cyclohexyl Sarin), and VX. Nerve agents cause effects on the human body by disrupting how nerves communicate and control muscles, glands, and organs.

NFPA 1981 Standard— Standard on Open Circuit Self-Contained Breathing Apparatus for Fire Fighters and Emergency Services Personnel. Updated every 5 years, it is part of the second tier of approval for the CBRN SCBA. The 1981 edition in effect, at the time of CBRN approval letter, is the edition the CBRN SCBA must demonstrate code compliance.

NFPA 1991 Standard— National Fire Protection Association Standard on Vapor-Protective Ensembles for Hazardous Materials Emergencies. The NFPA 1991 vapor protective ensemble provides a minimum level of protection against adverse chemical vapor, liquid splash, and particulate environments during hazardous materials emergency incidents. Optional test criteria is available for chemical flash fire escape protection, liquefied gas protection, and chemical / biological terrorism agent protection (chemical / biological terrorism agent protection is also addressed in the NFPA 1994 standard).

NFPA 1994 Standard— National Fire Protection Association Standard on Protective Ensembles for Chemical/Biological Terrorism Incidents. The NFPA 1994 Standard on Protective Ensemble for

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Chemical/Biological Terrorism Incidents (current 2001 Edition) sets performance requirements for protective clothing used at chemical and biological terrorism incidents. It defines three levels of ensembles (Class 1, Class 2, and Class 3) based on the perceived threat. The differences between the three classes are based the ability of the clothing design to resist the inward leakage of chemical or biological contaminants, the resistance of the materials used in the ensembles to chemical warfare agents and toxic industrial chemicals, the strength and durability of these materials. Ensembles are designed for a single exposure use, and consist of garments, gloves, and footwear. The NFPA 1994 Class designations should not be viewed as being equivalent to the OSHA protective clothing designations of Level A, B, C.

Non-encapsulated Ensemble— A type of liquid splash-protective ensemble that does not provide liquid-tight, vapor-tight, or gas-tight protection to the wearer and the respirator is fully exposed except for those portions that may be covered by the ensemble hood.

Non-Persistent— A common term used to describe the generally understood short duration time a chemical agent or any CBRN agent, remains on target or in the area.

Oxygen Deficient Atmosphere: An atmosphere which contains an oxygen partial pressure of less than 148 millimeters of mercury (19.5 percent by volume at sea level).

Persistent— A common term used to describe the generally understood long duration time chemical agent or any CBRN agent, remains on target or in the area. All factors such as weather, concentration, physical state,

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surface contaminated and temperature should be considered in determining if a CBRN agent is in fact persistent and capable of presenting a long term hazard to responders.

Nuclear Agents— Particulate-borne radiation dispersed by detonation of an improvised nuclear device (IND) or high/low yield nuclear detonation. An IND could consist of diverted nuclear weapon components or a modified nuclear weapon. INDs require fissionable material—highly enriched uranium or plutonium—to produce nuclear yield.

Penetration— The act or process of penetrating, piercing, or entering. As it relates to CBRN testing, it is a term that means exposing the respirator to specific quantities of chemical warfare agent with the express intent to see if the agent is stopped or if it penetrates through air pressure boundaries or material interfaces into the breathing zone of the respirator. If it penetrates under laboratory ideal conditions, most likely it will penetrate under confined space or enclosed space exposure conditions.

Permeation— The action of passing through the openings or interstices of a substrate at the surface level or the molecular level. As it relates to CBRN testing, it is a term that means exposing the respirator to a specific quantity of chemical warfare agent with the express intent to see if the agent is stopped and runs off or if it beads up and starts to permeate through air pressure boundaries or material surfaces into the breathing zone of the respirator or respirator accessories. If the agent permeates under laboratory ideal conditions, most likely it will permeate under confined space or enclosed space exposure conditions.

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Permissible Exposure Limit (PEL) - An enforceable regulatory limit set by the Occupational Safety and Health Administration (OSHA) on the amount or concentration of a substance in the air. PELs are set to protect workers against the health effects of exposure to hazardous substances and are based on an 8-hour time weighted average exposure.

Personal Protective Equipment (PPE)—Clothing and equipment used to shield or isolate individuals from the chemical, physical, and biological hazards that may be encountered at a hazardous waste-site. PPE should protect the respiratory system, skin, eyes, face, hands, feet, head, body, and hearing.

Positive Pressure Respirator—A respirator in which the pressure inside the respiratory inlet covering exceeds the ambient air pressure outside the respirator.

Protective Suit Ensemble—The complete personal protective equipment outfit (i.e., respirator, gloves, boots, clothing, ...) required for an event or task.

Radiological Agents—Particulate-borne radiation dispersed by detonation of a radiological dispersive device (RDD) or “dirty bomb.”

Rapid Intervention Crew /Company Universal Air Connection System (RIC UAC) —A portable compressed air system consisting of compatible interfaces that allows emergency replenishment of breathing air to the SCBA of down, disabled, or entrapped emergency responders.

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Rapid Intervention Team/Crew (RIT) — Designated firefighter search & rescue teams.

Rated Service Time—The manufacturer assigned value and a NIOSH-approved rated time of duration assigned based on breathable air that a respirator uses linked to air consumption at a moderate work rate.

Recommended Exposure Limit (REL) – An occupational exposure limit recommended by NIOSH as being protective of worker health and safety over a working lifetime. RELs are time-weighted average concentrations for up to a 10 hour workday during a 40-hour workweek.

Refugee Staging Area/Area, Staging, Refugee (RSA) — Area where suspected or actual contaminated personnel are isolated away from the CBRN contamination source. RSA is in the red zone but upwind of the source and allows for contaminated personnel to get out of contamination but not out of the Red zone.

Respirator Protection Program— A written procedure used to ensure that respirators are properly selected, used, and maintained by identified personnel. The program is to be administered by a suitably trained administrator and the program elements must meet the criteria specified in the OSHA respiratory protection standard (29 CFR 1910.134).

Terrorism — Per the Department of Homeland Security National Response Plan, it is any activity that (1) involves an act that (a) is dangerous to human life or potentially destructive of critical infrastructure or key resources; and (b) is a violation of the criminal laws of the United States or of any State or other subdivision of the United States; and (2) appears to be intended (a) to intimidate or coerce a civilian population; (b) to

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influence the policy of a government by intimidation or coercion; or (c) to affect the conduct of a government by mass destruction, assassination or kidnapping.

Toxic Industrial Chemicals (TICs)/Toxic Industrial Materials (TIMs) - a variety of chemicals used in various routine industrial processes which can, if inadvertently or deliberately released, possibly kill, seriously injure, or incapacitate people.

User Instructions (UI) – A NIOSH recognized manufacturer publication required to be submitted to NIOSH as part of a certification application requesting NIOSH approval. The UI are included with every new purchase of a NIOSH approved respirator.

User Seal Check - An action conducted by the respirator user to determine if the respirator is properly seated to the face.

Use Life/CBRN Respirator Use Life Time Value (CRUL) - Use limitation applying to the CBRN SCBA of a continuous 6-hour period beginning at the time of a confirmed exposure to a chemical warfare agent, after which the CBRN SCBA must be decontaminated and disposed of. Some variations on this rule are possible based on the decision authority by the incident commander or other authority commanding operations at the event site based on life saving priorities.

Warm Zone/Yellow Zone/Decontamination Zone— Area between Hot and Cold zones where personnel and equipment decontamination and hot zone support take place. It includes control points for the access

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corridor and thus assists in reducing the spread of contamination. Also referred to as the contamination reduction corridor (CRC), contamination reduction zone (CRZ), yellow zone or limited access zone in other documents.

Weapon of Mass Destruction - As defined by Title 18, U.S.C. 2332a: (1) Any explosive, incendiary, or poison gas, bomb, grenade, rocket (having a propellant charge of more than 4 ounces), missile (having an explosive or incendiary charge of more than one-quarter ounce), mine or similar device; (2) Any weapon that is designed or intended to cause death or serious bodily injury through the release, dissemination, or impact of toxic or poisonous chemicals or their precursors; (3) Any weapon involving a disease organism; or (4) Any weapon that is designed to release radiation or radioactivity at a level dangerous to human life.

Figure XX, Emergency Response Team, County Sheriff, Tactical Assault in Level C with SCBA, Circa 2000, Courtesy of Scott Health and Safety.

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Appendix B. Frequently Asked Questions (FAQ)

1 Is it always necessary to perform a “user seal check” on a CBRN SCBA respirator before each use?

Yes. In order to attain the proper designed seal to your face each and every time you don the facepiece, you should perform the manufacturer suggested user seal check/facepiece fit check. If this is not done every time, you risk entrapping contaminants, breathing contaminants or depleting the air source. Do not confuse a user seal check with a fit test. A user seal check is done by the wearer immediately after donning the SCBA facepiece to ensure a proper seal is attained prior to entering a given workplace requiring respiratory protection. User seal checks, also known as facepiece fit checks, and thus the confusion with the terms fit test, are also done if the user detects facepiece misalignment or cool air as a result of extended wear of the respirator or jarring of the facepiece while being worn. Whereas, a fit test is a qualitative or quantitative respirator performance test done with a selection of respirators on a human subject and by the respirator program administrator or a designated qualified individual. Performing a user seal check before entering a contaminated area is important to minimize contaminant leakage into the facepiece and to minimize leakage out of the facepiece that wastes air and reduces service time. User seal check procedures are located in Appendix B-1 of the OSHA Respiratory Protection Standard [29 CFR 1910.134]. Equally effective manufacturer’s user seal check procedures, which are located in the manufacturer’s user instructions specific to the model of respirator, are also acceptable. The OSHA procedures are located at:

http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9781

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3. How do I tell the difference between a NIOSH-approved CBRN SCBA and a NIOSH-approved SCBA, which is not approved for CBRN protection?

Look to see if the CBRN Agent Approved label shown below is on the respirator harness assembly. If a respirator is CBRN-approved by NIOSH, it will carry this adhesive label. The label is required to be located on the backframe of the SCBA in a highly visible location. If this CBRN Agent Approved label is **not** on the SCBA, the device is **not** approved by NIOSH for use in CBRN environments. **Check the CBRN Agent Approved label!** The label may also contain the word 'Retrofit' denoting that the SCBA was a previously deployed traditional industrial NIOSH approved non-CBRN SCBA which has been upgraded to CBRN protection status.

The font size of the NIOSH label may vary between SCBA manufacturers and the exact location of the label on the harness assembly is also at the discretion of the manufacturer. CBRN SCBA may also have unique markings for specific manufactured production models which are voluntarily designated by the manufacturer. These unique markings, if present, are not required for NIOSH approval, but are provided for the benefit of the user to distinguish CBRN protected SCBA from non-CBRN protected models in the same workplace. Unique markings can consist of color-coded adhesive labels prominently displayed on visible components of the CBRN SCBA, use of the printed letters 'CBRN' to identify second stage regulators, use of the letters CBRN on the side of the backframe or inside the facepiece or embossed facepieces with the letters CBRN.

4. Will a NIOSH approved SCBA that is not approved with CBRN protection protect me from CBRN agents? Do I have to use a NIOSH-approved CBRN SCBA in a CBRN response?

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A NIOSH approved SCBA that is **not** CBRN approved (referred to as an industrial or traditional NIOSH approved SCBA) has not been tested for penetration and permeation resistance to chemical warfare agents as part of its NIOSH approval. Because many chemical warfare agents (CWA) are highly aggressive in terms of their penetration and permeation ability, the traditional non-CBRN SCBA should not be relied on to provide protection against Chemical Warfare or Terrorism Agents. For protection against CWA gas/vapors and liquid contact, a CBRN SCBA should be used. The traditional non-CBRN SCBA should be limited to use to for protection against industrial exposures.

The traditional industrial non-CBRN SCBA provides industrial levels of protection against industrial gases, vapors and particulate aerosols including biological (bacteria and viruses) and radiological and nuclear particulate aerosols. The traditional industrial SCBA also provides protection against unknown industrial atmospheres, industrial IDLH conditions, and oxygen deficient industrial atmospheres.

5. Do I need to dispose of my NIOSH approved CBRN SCBA after use in a chemical warfare agent (CWA) contaminated environment?

Yes. Following use in an environment with the confirmed presence of chemical warfare agents (CWA) including GB, GA, GD, GF, VX, HD, HN-1, HN-2 and HN-3 and Lewisite in liquid, aerosol or vapor forms, the NIOSH approved CBRN SCBA must be removed from service and disposed of following **6 continuous hours** after the initial confirmed exposure. The SCBA should not be reused following this 6 hour time period and should be decontaminated and disposed of in a manner that is consistent with the type of contamination and any government regulations governing decontamination of

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contaminated items. Some variations on 6 hour use-life rule are possible at the discretion of the response scene incident commander or other appropriate authority and are discussed in this document in Chapter 6.

After use in an environment that **does not** contain CWAs, the respirator should be cleaned in accordance with recommendations from the manufacturer and current Centers for Disease Control and Prevention decontamination protocols.

6. How long can I use my NIOSH CBRN SCBA at the scene of a response?

The CBRN SCBA respirator should not be used beyond **6-continuous hours** after an initial confirmed chemical warfare agent (CWA) exposure in liquid, vapor or aerosol form to avoid possibility of agent permeation or penetration. Following the 6 continuous hour time period, the SCBA should be decontaminated and disposed of in a manner that is consistent with the type of contamination and any government regulations governing contaminated items. Some variations on this rule are possible and are discussed in this document in Chapters 5 & 6. If no CWAs are present, the SCBA should be used in accordance with the manufacturer's user recommendations for inspection, cleaning, and maintenance. If the SCBA was used in a response involving biological or radiological contamination, the SCBA will need to be decontaminated in accordance with manufacturer guidance and recommended CDC decontamination methods before reuse.

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7. Where can I find a list of NIOSH approved CBRN SCBA?

A list of currently approved CBRN SCBA is available on the NIOSH, NPPTL web site at:

<http://www.cdc.gov/niosh/npptl/topics/respirators/cbrnapproved/scba/>

8. Where are the user instructions specific for my CBRN SCBA model?

Every NIOSH approved CBRN SCBA is sold with a printed copy of the manufacturer's user instructions plus a NIOSH CBRN SCBA label insert. If you do not have a printed copy of the manufacturer's user instructions contact the manufacturer or equipment supplier to obtain a current copy. Integration of CBRN related user instructions is at the discretion of the manufacturer. NIOSH is available to assist in locating correct user instructions.

9. What hazards does the CBRN SCBA protect against? Which chemicals and particles, and at what levels?

NOTE: Read Chapter 2, Design Requirements and Components, for a detailed explanation of protection provided by a NIOSH approved CBRN SCBA.

- *Airborne industrial chemicals*—Chemicals used in industrial applications existing in the airborne states of gases, vapors, and solid and liquid particulate aerosols.

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- *Specific chemical warfare agents*—Protection is provided against GB (Sarin), GA (Tabun), GD (Soman), GF (Cyclohexyl Sarin), VX, HD (sulfur mustard), nitrogen mustard (HN-1, HN-2 and HN-3) and/or Lewisite (L, L-1, L-2 and L-3)
- *Particulate aerosols*—Solid or liquid chemicals are suspended in air. This includes protection against biological aerosols (bacteria and viruses), colloidal suspensions and particulates carrying radioactive isotopes.
- *Unknown atmospheres*—Atmospheres where the types of contaminants and their concentrations are unknown within the limitations of the SCBA.
- *IDLH atmospheres*—Atmospheres where the contaminant concentrations are known to be immediately dangerous to life or health (IDLH) within the limitations of the SCBA.
- *Oxygen deficient atmospheres*—Atmospheres known to contain less than 19.5% oxygen at sea level within the limitations of the SCBA.

10. How do I know if the facepiece is properly sealed to my face so I am protected?

You know this by conducting a correct user seal check that confirms the air tight seal interface between a correctly fitted and donned respirator and the physical dimensions of your clean shaven face. You should feel a slight vacuum pressure or overpressure when the negative or positive pressure user seal check is done and then you should detect no strange odors or sensations while breathing normally with the sealed respirator. With CBRN SCBA, fit testing as it is routinely done with special emphasis on maintaining serviceability of unique materials and components that make the SCBA CBRN compliant. This is

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normally done by adapting the SCBA facepiece to a negative pressure configuration and conducting quantitative fit testing with a calibrated fit test machine. Under OSHA, the respirator program administrator is responsible for managing the workplace respirator protection program and providing fit-tests to respirator users prior to initial use of the respirator, whenever a different respirator facepiece (size, style, model or make) is used, and at least annually thereafter to ensure continued, proper fit [29 CFR 1910.134(f)(2)]. Users should also undergo fit testing when changes in their physical condition could affect respirator fit. Such conditions include, but are not limited to, facial scarring, dental changes, cosmetic surgery, or an obvious change in body weight [29 CFR 1910.134(f)(3)]. The OSHA Respiratory Protection Standard [29 CFR 1910.134] mandates that facepieces, even for positive pressure units, be fit tested in the negative pressure mode. The respirator user should have the option to try different sizes of face pieces (for example: small, medium, & large) while undergoing initial and subsequent fit testing. The manufacturer can provide assistance by providing an adapter to test the SCBA facepiece in the negative pressure mode.

A user seal check is a method for determining whether a respirator has been properly donned (put-on) and properly adjusted to ensure a proper fit. Respirator users should perform a user seal check every time the respirator is donned, before entering a contaminated area, any time the user detects a seal breakage due to work rate and any time the respirator is doffed and re-donned due to hydration or rest cycles. A user seal check evaluates the seal of the respirator to the user's face by having the user put the facepiece

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under positive or negative pressure and noticing leakage. User seal check procedures are located in Appendix B-1 of the OSHA Respiratory Protection Standard [29 CFR 1910.134]. Manufacturer's user seal check procedures, which are located in the manufacturer's user instructions specific to the model of respirator, are also available and provide unique product insight to the workings of the respirator.

11. What type of training do I need to ensure that I can properly use a NIOSH approved CBRN SCBA respirator?

The respirator program administrator is responsible for establishing a training program in compliance with the OSHA Respiratory Protection Standard [29 CFR 1910.134].

Employees should be trained on the following aspects:

- Why the respirator is necessary and how improper fit, usage, or maintenance can compromise the protection of the respirator;
- What the limitations and capabilities of the respirator are;
- How to use the respirator effectively in emergency situations, including situations in which the respirator malfunctions;
- How to inspect, put on and remove, use, and check the seals of the respirator;
- How to recognize medical signs and symptoms that may limit or prevent the effective use of respirators

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- Unique CBRN SCBA user instructions and locations of CBRN NIOSH label confirming CBRN approval of the CBRN SCBA or upgraded SCBA to CBRN protection.

12. Is it necessary to wear a protective suit ensemble or protective clothing in conjunction with a CBRN SCBA?

Some CBRN contaminants produce toxic effects by contact with the skin and these effects can be immediate or delayed depending on the type of contaminant. NIOSH has issued Caution and Limitation 'Q' for the CBRN SCBA stating:

“Q Use in conjunction with personal protective ensembles that provide appropriate levels of protection against dermal hazards.”

Although CBRN SCBA are approved by NIOSH as stand alone respiratory protection devices and not in tandem with a protective suit ensemble or other type of protective clothing, this statement advises users that an appropriate level of protective clothing should be worn with the CBRN SCBA based on the need for dermal protection against CBRN hazards.

CBRN SCBA are designed by manufacturers to be compatible with various levels of protective clothing, including encapsulating suits (those which completely enclose the wearer's entire SCBA) and non-encapsulating protective suits (suits which partially enclose or cover the SCBA). The type of protective clothing or protective suit ensemble must be based on dermal protection needed for the identified type of CBRN hazard. The user must

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be outfitted with an appropriate protective ensemble or protective suit to protect against skin absorption. The selection of the protective ensembles must relate to recognized definitions of the types of ensembles that can be used for CBRN incidents. It is not the intention to use the certified CBRN SCBA for multiple incidents however; it may be possible to reenter specific CBRN incidents following a quick gross decontamination and clean replenishment of air supply. If the protective suit is compromised and a non-CBRN approved SCBA is worn instead of a CBRN approved SCBA, the interior of the suit becomes a confined space allowing for agent to attack the dermal areas and respiratory system. Chemical warfare agents most predominate route of entry is the respiratory system. Adequate protection provided by a NIOSH approved CBRN SCBA will ensure minimum respiratory protection is provided even if the suit is compromised. This protective quality may offer just enough time for the wearer to escape contamination and go to a less contaminated area for immediate decontamination. A properly maintained and donned NIOSH CBRN SCBA provides the highest level of respiratory protection available to Level A or Level B outfitted responders.

13. Will wearing a protective suit ensemble protect my CBRN SCBA from becoming contaminated?

Only protective clothing ensembles designed to enclose an SCBA within an encapsulating suit, those which completely enclose the wearer's entire SCBA, or non-encapsulating suit, suits which enclose but are not vapor tight, will provide a level of protection for the SCBA hardware to prevent or reduce exposure of the SCBA to contamination. Protective clothing

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ensembles that expose the CBRN SCBA visor and second stage regulator to ambient toxic concentrations should be limited to vapor exposures if possible. It is expected that CBRN liquid agents will attack any open crevice between the respirator facepiece and the protective ensemble hood or collar. If known CBRN liquid exposures are expected or determined, emergency responders should require full Level A encapsulated ensembles to protect the entire responder and SCBA. Next generation of improved Level A ensembles or variations of that ensemble are incorporating unique respirator to suit interfaces that bridge the gap that chemical tape (Chem Tape) does now. NFPA compliance standards designed to test ensembles do not allow the use of chemical tape (specific adhesive tape that is designed by manufacturers to be chemically resistant to CBRN agents when applied correctly).

EPA Level A and B defined levels of personal protection utilize SCBA and specific protective suit ensembles with accessories. EPA Level A suit ensembles are vapor, aerosol, solid, liquid and gaseous protective against known specific industrial agents. NIOSH CBRN Approvals do not exist for EPA Level A, B, C or D protective suit ensembles. NFPA compliance testing of given protective ensembles is occurring and is expected to provide a level of CBRN protection under a given laboratory condition. EPA Level B suit ensembles are liquid-tight and provide protection from liquid splashes but do not protect against chemical vapors or gases. NIOSH recognizes that the protection provided by a Level A or Level B encapsulated suit will likely prevent CBRN contamination from contacting a NIOSH CBRN SCBA depending on the physical state of the CWA (liquid or

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gas/vapor state) and the corresponding Level A or B suit but currently does not issue approvals to that effect. In these instances where the appropriate level of encapsulated suit is used corresponding to the physical state of the CWA, the limitation of 6 continuous hours of use from the time of initial chemical warfare agent (CWA) exposure would not apply until the suit is compromised or the CBRN SCBA is inadvertently or deliberately exposed to CWA contamination as a result of doffing, fair wear and tear or direct or collateral physical or puncture damage.

For Level B ensembles which are non-encapsulating, the CBRN SCBA head harness must be on the inside of the ensemble and not be directly exposed to ambient hazards. If the head harness is worn over the protective hood, the fit test sealing properties will most likely not be replicated or the facepiece will have to be tightened excessively to attain a proper seal. While this process may seem to bridge the suit to respirator interface gap, it does not allow the suit to fully protect the head area and may compromise the sealing properties of the respirator facepiece. Those SCBA components exposed to the environment, such as the lens of the facepiece, should be considered contaminated if used in a CWA agent environment, and for those components, the 6 hour use limitation will apply.

In the case of protection against chemical warfare agents, not all chemical protective suits are tested and rated protective against chemical warfare agents. A suit ensemble which has been tested to provide protection against CWA must be used if CWA protection is required.

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14. How do I determine my 'Non-CBRN' NIOSH-approved SCBA can be upgraded to NIOSH- approved CBRN protection?

Please contact the respirator manufacturer first. Concurrently or subsequently, visit the NIOSH NPPTL website to locate the model of SCBA in use and whether it has a NIOSH approved CBRN Upgrade/Retrofit Kit available. Select models of previously deployed traditional 'non-CBRN' NIOSH approved SCBA can be upgraded for protection against CBRN agents using procedures and materials designated by NIOSH. The best source of help for this question is to contact the respirator manufacturer of the currently deployed traditional industrial unit to determine if it is capable of being upgraded. A manufacturer's representative may need to physically inspect the unit to determine if it is a model that is capable of being upgraded to CBRN protection status. Only NFPA 1981, editions 1997 and 2002 have NIOSH approved CBRN SCBA Upgrade Kits approved and in production.

The CBRN SCBA upgrade procedure involves accurate configuration management, identification of field deployed SCBA that are eligible for upgrade, the installing of specific new parts, inspection, testing, re-installation of defective components found during inspection, adding new CBRN Retrofit labels and instructions. This CBRN SCBA Upgrade approval signifies that the products receiving the upgrade are expected to protect firefighters and other emergency responders from CBRN-related gaseous, airborne particulate, and liquid respiratory exposures. NIOSH based its determination on positive results from rigorous laboratory tests, evaluation of product specifications for the upgrade procedures, materials, and an assessment of the manufacturer's quality control procedures.

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A bill of materials identifying the various models of SCBA eligible for CBRN SCBA upgrades is available from the manufacturer. CBRN SCBA upgrade of a SCBA should not be done by untrained or unauthorized personnel. Contact the SCBA manufacturer for specific CBRN SCBA upgrade programs available.

Figure XX, Field Deployed SCBA with CBRN SCBA Upgrade Kit Complete, 2003, Courtesy NIOSH and MSA. Notice the “CBRN” letters on the second stage regulator.

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Appendix C: Sample NIOSH Approval Label

The following items are integral to configuration management of NIOSH CBRN SCBA.

They are the NIOSH Approval Letter, the NIOSH approved parts list, known as an 'assembly matrix', the NIOSH exploded view drawing, the NIOSH test results, the NIOSH adhesive labels on the harness assembly, and the "CBRN Agent Approved" adhesive approval labels and if applicable, the adhesive CBRN Agent Approved (Retrofit) approval label. The below example is a of an actual CBRN SCBA approval label paper insert that is required to be in the user instructions of the CBRN SCBA.

(DRAWING is extracted for ease of emailing document for comments and discussion. 24March05, TKC)

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Appendix D: User Guidance Checklist

1. Are CBRN SCBA available for all first responders/first due units, select few or none?
2. Are CBRN SCBA available from mutual aid departments?
3. Do actual responders have basic and advanced WMD awareness training prior to entering an unknown situation with SCBA or CBRN SCBA?
4. Are the drivers of incoming responder vehicles trained to drive with CBRN SCBA donned?
5. Are cabins of incoming responder vehicles over-pressurized to maintain a level of protection to passengers in or out of CBRN SCBA?
6. If you have just purchased new or upgraded CBRN SCBA, do you have complete confidence that all unique CBRN protection characteristics of the SCBA have been explained and understood?
7. Are emergency and deliberate entry SOPs updated to include the use of CBRN SCBA?
8. Are provisions in place to supply CBRN approved respirators to initial and triaged casualties?
9. Are on hand Level A protective ensemble pass thru devices compatible with CBRN SCBA?
10. Does local SOP or SOG emphasis proper respirator fit testing; head harness worn over head instead of outside on hood or ensemble and training on CBRN SCBA use life?
11. Who is the CBRN SCBA hydrostatic tester?
12. Is the CBRN SCBA fully assembled?
13. Is the CBRN SCBA fully operational?

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14. Does the CBRN SCBA show the correct NIOSH CBRN label confirming the system is CBRN approved?
15. Do the part numbers listed on the NIOSH CBRN Label insert located in the user instructions, match the part numbers visible on the CBRN SCBA?
16. Are all manufacturer unique CBRN markings readily known by the wearer?
17. Are all before operations checks complete?
18. Are CBRN SCBA decontamination plans in place?
19. Are CBRN SCBA disposal plans in place?
20. Are CBRN SCBA replacement parts and systems in place?
21. Are CBRN SCBA air compressed cylinders full and in ample supply for cylinder changing out in a clean staging area? Are universal cylinders in use?
22. Is an established CBRN SCBA use life protocol available and capable of being implemented?
23. Are compatible protective ensembles available to provide dermal protection?
24. Are proper handling techniques established and rehearsed on handling contaminated CBRN SCBA after each use or between multiple entries during the same use?
25. Are decontamination and disposal procedures followed as required? Are manufacturers consulted on recommended decontamination procedures?
26. If liquid CBRN agents contaminate the CBRN SCBA, are disposal actions in place to discard the CBRN SCBA after decontamination actions are complete?
27. Is the respirator used beyond 6-hours after initial exposure to chemical warfare agents? If so, confirm no contamination is present. If contamination is present, ensure CBRN SCBA is not

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used beyond 6-hours after initial exposure to chemical warfare agents to avoid possibility of agent permeation into SCBA materials or breathing zone.

28. Is a CBRN SCBA Upgrade Kit in use? If so, is it fully functional and compatible?

DRAFT

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Appendix E, CBRN SCBA Training Aid Pamphlet

(It is provided as a separate Excel file attached to this document upon receipt of the file for review.)

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